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Some Notes on High Pressure Gas Lighting.

[By a LONDON CORRESPONDENT.]

During the last 10 years one of the most remarkable steps in the progress of gas lighting in England and on the Continent has been the development of high pressure gas lighting. At the beginning of this century the method was very little known, and certainly very few people would have thought it possible to employ pressures in the pipes as high as those we are using now.

A few experiments were, however, being made in England at that time. For example, in 1901, Blackfriar's Bridge was illuminated by Sugg incandescent gas lamps, using 10 inches pressure, and in the same year Mr. Onslow read a paper describing the new installation at Woolwich Arsenal, where as much as 55 inches of pressure was used. He predicted that pressures of this order would come into general use before many years had passed; and, sure enough, to-day these are now very much exceeded.

Within the next few years quite a number of installations attracted attention in London. The famous high pressure lighting installation in Whitehall was for a time almost unique, and another installation which attracted some attention was that at Victoria railway station.[1] Within the last few years, however, we have seen a considerable number of streets so illuminated, many of them in the most fashionable quarter of London, and the introduction of lamps giving a rated candle power of 2,000 (or even 4,000 candle power) has become quite usual in most European cities. Indeed, the remarkable progress of high pressure lighting in Berlin early excited great interest in this country, and only two years ago the city of London appointed a special commission to visit various Continental cities and report on the progress made. During 1910 a very important decision was taken by the Westminster City Lighting Committee, to illuminate a large section of streets by high pressure gas, the contract being entered into with the Gas Light and Coke Company, which offered to light the streets with lamps of either 3,000 or 1,800 nominal candle power, at a cost of £22 (approximately $110), and £15 10s. (approximately $77), respectively, per lamp per annum. The streets so lighted include Picadilly, Regent street St. James's street, Pall Mall, and other important thoroughfares.

Quite recently an important decision to improve the public lighting has likewise been taken in the city of London, but in this case a combined system of gas and electric lighting has been adopted, some streets being lighted by flame arc lamps, and others by 2,000-candle power high pressure gas lamps. The benefit to be derived from the new scheme will be understood when it is computed that in this quarter of London alone there will be an increase of about 600,000-candle power, and an annual saving of over £6,000 (approximately $30,000.)

It will be seen, therefore, that high pressure gas has been making considerable headway for public lighting in London. In Berlin, as stated above, the method was developed by the municipal gas works even earlier, and very large extensions have recently been made in the Tegel works. Other Continental cities have also made considerable advances. High pressure gas lighting is also making considerable headway for lighting large factories, for exterior shop lighting, etc.

Fig. 1 shows a typical high pressure installation in the district of the Gas Light and Coke Company (to which the writer is indebted for this photograph), in Pall Mall, in the West End of London. Fig. 2 shows an installation in the district of the other great London Gas Company, the South Metropolitan, which was described in a recent number of the *Copartnership Journal*. As a result of the recent change from low pressure to high pressure gas lamps outside Lambeth Town Hall, the total candle power has been increased 5 times, and the pressure is stated to have the high value of 80 inches of water. This, however, is now hardly unusual, pressures of over 100 inches being occasionally used.

The great advantage in high pressure gas lighting is, of course, the gain in efficiency. With the ordinary low candle power, 2-inch pressure lamps, as much as 20-candle power per cubic foot is considered about the limit, although, during the present year, a remarkable advance in high candle power, low pressure lamps appears to have been obtained; quite a number of firms announce lamps which are stated to give up 40-candle power per cubic foot. This remarkable result appears to be due mainly to the more scientific use of the waste heat for preheating the gas and air mixture. This, however, is still considerably below the results attainable with high pressures, as much as 60 to 70-candle power per cubic foot being claimed for the latest

1. AMERICAN GAS LIGHT JOURNAL, Oct. 4, 1909, p 814.

Fig. 1.—Lighting of Pall Mall, London, by High Pressure Gas.

Fig. 2.—High Pressure Gas Lighting, Lambeth Town Hall, Brixton Hill, London.

high pressure inverted lamps. The pressure on a large number of installations is in the neighborhood of 55 inches at the burner, but the pressure in the pipes is frequently allowed to rise to much higher values than this (*e. g.*, in the case of the Lambeth Town Hall installation, referred to above, and the tennis courts at Dulwich, described in this JOURNAL some time ago.[1]

The public lighting compression is, of course, attended to by the

1. See JOURNAL, Oct. 23, 1911, p. 258.

co npany. the gas being compressed by the aid of a gas engine or electric motor and distributed through pipes in the usual way. Some authorities look forward to a time when both a low pressure and a high pressure supply will be available in most towns, and even at present it is becoming quite usual for the shops to be lighted by low pressure gas inside, but to utilize several powerful lamps off the high pressure supply outside. In many other cases in which a high pressure supply is not available a local compressing plant is installed in a factory and distributed through the building.

It may be noted that the use of gas at a high pressure is beneficial simply because it promotes an intimate mixture of gas and air and complete and rapid combustion. Preheating also appears to be particularly advantageous in connection with high pressure lamps, and the high efficiency arrived at with the most recent types of lamps is partly ascribed to this cause.

But similar results as regards efficiency can also be obtained by using an ordinary low pressure gas supply, but leading into the burner a supply of *high pressure air*. This method has not yet been used to any great extent in England, but has been largely developed by the Pharos and other companies on the Continent. A great deal of discussion has recently waged around the relative advantages of the two methods. It has been argued, for example, that by using high pressure air one avoids the necessity for using special meters, that the risk of leakage from high pressure gas is obviated, and that an existing low pressure installation is very readily converted without interfering with the existing gas piping. On the other hand, the advocates of high pressure gas contend that in practice the danger of leakage of gas can be reduced to negligible proportions, that the existing piping will often answer with comparatively little overhauling, and that the high pressure air system in any case entails the laying of an extra set of air pipes, small though they may be.

There remains another high pressure system, one of the best known examples of which is the "Selas," in which a mixture of air and gas is compressed and distributed at a comparatively low pressure of about 10 inches. Certain advantages for this method are claimed but it appears to be practically confined to private installations. The high pressure system can be applied to either upright or inverted mantles, and the majority of the lamps recently installed in the London streets are of the latter variety.

High candle power lamps of 2,000 to 4,000-candle power employ a series of mantles, and this has several advantages. For example, if one mantle out of three should be broken or damaged the other two will continue to give their normal light so that the candle power as a whole will probably not be reduced by more than a third. Again it is clear that, if the mantle which diminishes in candle power first is renewed there will in general be several of the group of mantles giving nearer their initial candle power at any moment, where, with a single mantle, the light as a whole will fall off by about 20 per cent. or so before it is considered necessary for the mantle to be renewed. Consequently the use of a group of mantles tends towards a more constant candle power.

Another advantage is that means can be arranged for two out of three mantles to be extinguished at a given hour each night, when the busiest traffic is over, leaving a smaller amount of light but still sufficient to prevent the streets being in total darkness. This is the more important because the automatic control of street lamps by a "pressure wave" from the works is becoming very usual. By such automatic methods not only are the inconveniences of hand labor to a large extent obviated, but there is also stated to be distinct saving in the number of mantles, chimneys, etc., broken during the year.

There were originally a number of difficulties experienced in connection with the mantles for high pressure lighting which naturally have to be specially strongly woven or knitted to withstand the exceptional pressure. These early difficulties seemed to have been largely overcome, however, and it is even stated that the mantles now in use in some of the districts in Berlin for public lighting will last for as much as 1,000 lighting hours.

As explained above, most of the latest types of gas lamps employed for public lighting are of the inverted type. Possibly owing to this there has recently been much discussion as to the desirability of suspending these lamps over the center of the roadway. This question, for example, was discussed in the well-known paper, read by Mr. F. W. Goodenough, before the Illuminating Engineering Society in 1910. Quite a number of years ago the idea of hanging electric arc lamps on wires spanning the streets was introduced on the Continent, and the deputation of the city of London, which visited the Continent in 1909, brought back with them the suggestion that this system of lighting should be applied to high pressure gas lamps. To many people at that time the idea of suspending gas lamps in this way, and arranging for them to be lowered and receive attention and raised again, with same facility as arc lamps, was entirely new. Mr. Leon Gaster, however, in his "Cantor Lectures," before the Royal Society of Arts (1909) described an installation of this kind in experimental use at Stuttgart, and this was apparently one of the first of such installations to be attempted. In Berlin, however, Messrs. Ehrich and Grätz had been working with a type of lamppost which enabled high pressure lamps to be raised and lowered to receive attention without interrupting the supply of gas. The gas was led to the lamp by means of flexible or jointed tubes which accommodated themselves to the position of the lamp as it was lifted.

In the "central suspension" method, either flexible or jointed pipes are also used, and arrangements are made for the lamp to be first drawn to the side of the road and then let down. This method has now been used in the city of London for some time, and to the uninitiated the gas lamps hung in this novel way have often been mistaken for electric lamps. We see here one more illustration of the tendency, by hook-or-crook, to provide the same facilities for all illuminants and to imitate in the one case what has already been done successfully in the other. The latest scheme for the city of London provides for the lighting of quite a number of streets in this way. It has been claimed that central suspension on wires has the great advantage of doing away with lampposts which, especially when in the center of the roadway, present a certain obstruction to the traffic, and of enabling a more uniform method of illumination over the roadway to be obtained. On the other hand, it must also be remembered that it is not always convenient to obtain permission to attach wires to the houses lining a street. It has also been suggested that the accumulation of overhead wires, besides being somewhat unsightly, is an inconvenience to the occasional passage of tall objects such as fire escapes.

One other development in gas street lighting deserves to be mentioned. The introduction of high pressure gas has led to a rather sudden advance in the brilliancy of lighting in important thoroughfares. Sometimes the side streets have been so comparatively feebly lighted in comparison that the driver approaching from a side street is apt to be dazzled and bewildered as he turns the corner into an important thoroughfare. In Stuttgart, therefore, the proposition has been made that the side street lighting should be graded. Low pressure units will be employed, but the candle power of the lamps lining the street will be gradually increased as the main thoroughfare is approached. There may be, for example, 250-candle power lamps at the far end, 500-candle power lamps about the middle, and 1,000-candle power lamps at the end adjoining the main street. In this way the shock of emerging from comparative obscurity into the brilliant surrounding is diminished.

On the other hand, it may be questioned whether the dazzling effect in such cases is not due rather to the brilliancy of the lamps themselves than to the illumination provided. Hehce it need hardly be said that a lantern containing a group of these high-pressure mantles is a very brilliant object, and it is probable that if the lamps could be screened in some way without undue loss of light, street lighting as a whole would benefit. At present these powerful lamps are hung as high as possible, but it seems likely that, during the next few years, we shall see a steady movement in favor of some form of screening by appropriate reflectors. Light can now be produced in such comparative abundance that we should surely be able to afford a certain loss in order to avoid glare. The speeding up of the traffic of great cities, and the universal adoption of motor vehicles only serve to show how important it is to avoid as far as possible the dazzling effect of these bright sources.

Attention may next be drawn to the application of high-pressure lighting in factories. The 55 inches pressure, so frequently employed for public lighting, is not always used here, the pressure being under the control of the consumer in a private installation. When a very powerful light is not needed 10 inches is sometimes used. One or two interesting installations of this kind were referred to in *The Illuminating Engineer* in 1910. Two illustrations of these are reproduced in Figs. 3 and 4.

Fig. 3 shows a stonemason's yard illuminated by Keith, high-pressure, inverted gaslights. An interesting point that arises in this case is the effect of the fine stone dust. The dust from stones, being of a comparatively heavy kind, soon settles to the ground and does not cause much trouble. It is well known that in flour mills, on the

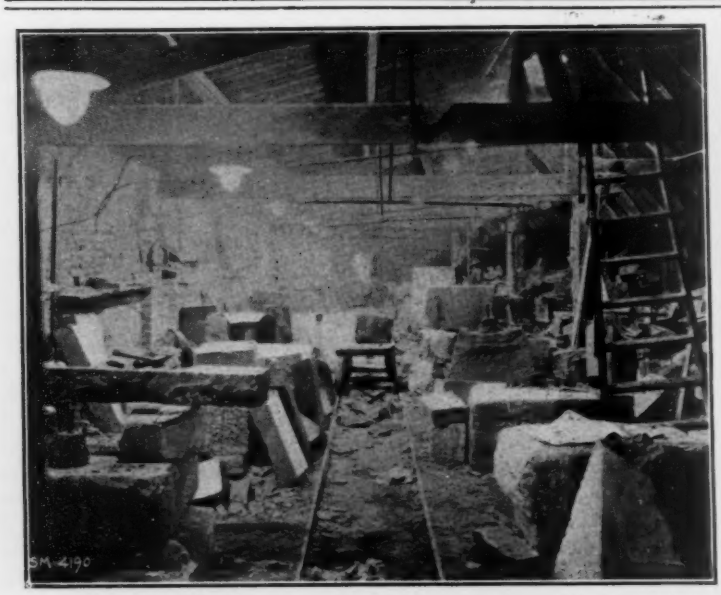

Fig. 3.

Fig. 4.

other hand, the finer dust materially affects the life of the mantles, being sucked in and left as a carbonized deposit. But here high-pressure lighting is regarded as a distinct advantage, for the pressure tends to force the dust through the burner and prevents its being gradually choked by the accumulation of fine particles. Fig 4 shows a compositor's room lighted by 100-candle power inverted units. These are provided with opaque reflectors concentrating the light over the benches.

And now a word or two may be said on the subject of high pressure gas lamps for shop lighting. This subject was dealt with in a recent paper before the Illuminating Engineering Society, by Mr. A. E. Broadberry, who showed a considerable number of illustrations of shops lighted by both low and high pressure gas.

Two of these are reproduced in Figs. 5 and 6. In one case the lamps had been left exposed for spectacular purposes, and in the other were equipped with reflectors concentrating the light on the windows. Fig. 5 shows the exterior illumination of some provision stores by three 600-candle power, high pressure lamps. The horizontal illumination of the footway is stated to be about 4½ to 5½ foot-candles, and the surface brightness of the objects in the forefront of the window is of the order of 16 to 25 foot-candles. Fig. 6 is a boot-shop, and the illumination of the window is again exceptionally high.

The actual costs of high pressure lighting have been the subject of much discussion, and those interested in these matters are or may be referred to a very interesting discussion in a recent number of the *Journal of Gas Lighting*. As an example of the figures put forward by gas representatives the following (given by Mr. Farquhar, of the Ilford Gas Company) may perhaps be quoted:

Fig. 5.

Fig 6.

Actual Cost of High Pressure Gas Lamp.

	£	s.	d.
Lamp costing £4 10s., over 8 years, including interest		13	9
Globes and mantles, per year		6	10
Maintenance, cleaning lamps and looking after compressor		16	4
Cost of compressor spread over number of lamps in use, over 20 years (including interest)		1	1
Gas at 2s. 6d. per 1,000 cubic feet	1	17	11
	£3	15	11

The charge to the consumers for these lamps (rated at 1,000-candle power) is thus under £4 (approximately $20) per annum. In this article it has only been possible to mention a few main applications of high pressure gas lighting. Readers desiring fuller particulars may be recommended to read the papers by Mr. Goodenough and Mr. Broadberry mentioned above.

Address of the President of the Southern Gas Association (Mr. H. B. Hoyt, of Jacksonville, Fla.), Delivered at the Fourth Annual Meeting, Jacksonville, April 17, 18 and 19.

In this, the annual address of your President, desiring to be practical and helpful, I will be plain in my observations and recommendations, and frank in my words of praise and frank in my criticisms.

Membership.—The membership of the Southern Gas Association at the close of the Montgomery (1911) meeting was 116 members. Since that meeting, 86 members have been added. This increase is due, to a large extent, to a systemmatic membership campaign, with Mr. George Williams as General Chairman of Membership Committee, and the following gentlemen as Chairmen of State Committees :

Alabama	K. L. Simons.	Mississippi	A. B. Paterson.
Arkansas	E. C. Beach.	Missouri	T. D. Miller.
Florida	J. N. Cooke.	North Carolina	F. H. Sawyer.
Georgia	L. N. Young.	South Carolina	S. W. Brown.
Louisiana	J. P. Ingle.	Tennessee	S. E. DeFrese.
Texas	H. M. Moore.		

To the General Chairman, and to the Chairman of State Membership Committees, I desire to express the sincere appreciation of the Association. New members have come from States as follows:

Alabama	11	Louisiana	5	Pennsylvania	8
Arkansas	3	Michigan	1	South Carolina	5
Connecticut	1	Mississippi	2	Tennessee	2
District of Col	1	New York	1	Texas	3
Florida	16	North Carolina	5	Wisconsin	1
Georgia	12	Ohio	2		

Florida has shown the highest gain, Mississippi the lowest. An analysis of the new membership list shows that the large operating companies have given our Association their hearty support, but that the independent companies, owned entirely or largely by local capital, have not responded so well to the new membership campaign. It should be a source of satisfaction to be thus recognized by these strong and intelligent syndicates; but it is also a cause for regret that so many independent companies, especially the smaller ones, have either not been reached, or else have not been made to appreciate the value of Association membership. In my opinion, the independent company, having no general organization, needs the Association more than the syndicate company, with its well organized departments and its experts at the head of these departments. The appliance companies doing business in the South are now well represented in our membership list, and the thanks of the Association are due to the Southern representatives of the Northern appliance companies for their co operation with the Membership Committee in recruiting new members, both Active and Associate. There are in the territory embraced by the Southern Gas Association, 99 artificial gas companies and 17 natural gas companies, a total of 116 companies. Of these companies, only 44 have membership in the Association; or 62 per cent. have no representation at all in the Southern Gas Association. While I am gratified with the results of the membership campaign, I deem the matter of still further extending our membership of paramount importance. I suggest that the plan as followed this year be continued, but with more vigor. A closer organization should be brought about by and between the officers of the Association and the General Chairman of Membership Committee and Chairmen of State Committees. The full Membership Commiittee, together with the officers of the Association, should meet together at least twice during the coming year; and I would suggest, as place and time for first meeting, Jacksonville, April 20th; and, for second meeting, Atlanta, during the first week of December. State Chairmen should report frequently to General Chairman and to the Secretary, all of whom should be in constant touch with each other. Circulars have proved useful and should be continued; but circulars do not have the pulling power of personal letters, written either by some officer or committeeman, or by that member who can exert the most influence on the company or individual who has failed to respond. Increased membership is desirable:

(1.) From the broad altruistic reason of offering and affording to all Southern gas men and gas appliance men the benefits which we know are real and material, and which we do not need to enumerate.

(2.) Increased membership is desirable, for the reason that it will give us more power and prestige in our own section, and in the country at large.

(3.) Increased membership is desirable for the reason that it will give us a membership that will be more fully representative, and will give us more men from whom to draw material for our papers, question box, etc.

(4.) Increased membership is desirable, for the reason that it will give us more revenue, and more revenue is needed now and, without doubt, will be more imperatively needed in the future. Our expenses for the past fiscal year were over $1,000, and economy has been practiced.

(5.) Increased membership is desirable, because there is enthusiasm in numbers; and there is energizing power, too; for momentum is equal to mass multiplied by velocity.

Let us work, organized and as individuals, to increase our membership. Let us have when we assemble next year, a total of at least 350.

Dues.—According to our Constitution, dues are $10 for the first year, including initiation fee. Dues for second and succeeding years are $5 per year. I would suggest that dues, including initiation fee, be changed to $5 for the first year. I can see no important reason for charging $10 for first year, in that we give nothing more for the first year than for any succeeding year; and, then, is it good salesmanship to charge twice as much for the first article as for any other? It is good salesmanship in general to offer an inducement to buy, by making the price of the first article no more than the second, and at times by making the price of the first article even less than the second. I believe gas association dues should be paid by the employing company; but, whether paid by employer or employee, there will be more hesitancy in paying $10, as at present, than $5. I believe that $5 for initiation fee and first year's dues will increase our membership and increase the cash balance in our treasury.

Officers.—The officers of the Southern Gas Association since organization have been well distributed as to individuals and States. The four Presidents have been from Louisiana, Georgia, Tennessee and Florida—one term each. I urge the necessity of seeing to it that the officers be, and continue to be, from the various States, and that the hazard be avoided of continuing too long in office any man or set of men, or of giving any man or set of men preponderance of control or influence.

Programme.—I deem it important that the different departments of our industry be covered by papers read and discussed at our meetings, that no department receive undue prominence, and that no department be neglected. A difficulty has been experienced in the past, in getting papers along the line of manufacturing, and our programmes have shown too little material in this important division of our business. It is not a fact that the gas industry is standing still in manufacturing; but it is a fact that new processes are being tried out, and improvements are being made that mean greater efficiency and economy. I urge the man at the works to take part in the preparation of papers and in the discussions, for much as we esteem the other departments of our industry, we must never forget that the man at the works is still the man to whom we ought to look, and do look, for good gas, and that his efficiency and the efficiency of the works he operates make possible lower rates to the consumer, and that good gas and low rates are ardently desired by the capitalist who owns the plant, as well as by the consumer who buys the product.

There are necessarily, and properly, two sides to any gas association meeting. First, the solid practical side, comprising the regular business sessions for the consideration of papers, discussions, reports, etc. It is for this solid practical side of a gas association meeting that a gas company sends its employees, pays their membership dues, and their traveling and hotel expenses. It is for this solid, practical side that the majority of members have joined, and for which they attend the association meetings. The other side of a gas association meeting is the lighter, social side. Far be it from me to decry the value of this lighter, social side; but I do go on record as saying that the lighter, social side is and ought to be of secondary importance. There is no good reason against "having a good time," and there are plenty of reasons in favor of "having a good time;" but, at the risk of being accused of preaching, I say that no member attending a gas association meeting should "have a good time," if to "have that good time" means a real neglect of the solid, practical side, by failure to attend the regular business sessions. I say, further, that no member should "have a good time," if to "have a good time" he must indulge in excesses. I say that no member should "have a good time," if to do so he must make a public banquet or a smoker appear in the eyes of a disinterested person to be a bacchanalian revel, with jest and song unworthy of the representatives of a dignified and a most important industry. Let us enjoy ourselves; but let us remember why we attend a gas association meeting. And, let us remember who we are.

Bureau of Information.—The question box is made up of real and hypothetical questions. Both are answered very well, and these answers are beneficial to the questioning gas man, and more or less to the gas man in general. The question box, however, comes out but once-a-year, and as it is impracticable for our Association to publish a monthly periodical, the suggestion has been made that an information bureau be constituted, this bureau to receive questions and to make answers thereto direct by mail to the questioner. I consider this idea a good one, and I would suggest that we organize an information bureau, the details to be worked out by a committee to be appointed at one of the early sessions of this meeting, and to report before the close of this meeting.

Advertising.—It has been said that the South is unsystematic in its advertising. I am not prepared to affirm or deny this statement,

but I do believe the subject should be given more attention and more study, that we should appreciate the fact that advertising is both a science and an art, and that advertising campaigns should be worked out with the same quality of painstaking care and good judgment as is used, for instance, in the building of a new works, or the laying of a new distributing system. Advertising should not be done by nor for the day, by "day" men, but should be planned out for months and years, by men who are paid by the month or year or by specific contract, to design advertising policies and campaigns, both as to broad generalities and special details.

At the 1911 meeting of the National Commercial Gas Association, the Advertising Committee of that Association submitted a report, outlining and recommending a National Advertising Campaign. That was a notable report, for I believe the project of a National Advertising Campaign offers inestimable benefits to the Gas Industry in the United States, and particularly to the industry in the South, and I believe that the project should receive the endorsement and support of our Association, and of the companies represented therein.

National Commercial Gas Association Meeting, 1912.—The South is proud to have the honor of entertaining this year the National Commercial Gas Association, to be assembled in Atlanta, Ga., next December. This meeting will be beneficial to the gas industry in the South, and to the Southern gas man. Our appreciation of the honor of being host to this, one of the largest commercial organizations in the world, and the largest gas organization in the world, should be expressed, in a practical manner, by giving a large new membership to the National Commercial Gas Association, and by taking to Atlanta a big Southern delegation, and by assisting the Atlanta Gas Light Company to make this meeting a full and complete success. We must do our part to prove to our friends from the East, the West, and the North, that the hospitality of "Dixie" is not a shallow boast; but is sincere, and warm, and substantial. In conclusion, I desire officially to express appreciation for courtesies received from the Editors of AMERICAN GAS LIGHT JOURNAL, *The Gas Industry and Progressive Age.* I also desire officially to express appreciation for the work done by Mr. Whittaker, Editor of the "Question Box," and by Mr. Bowlin, as Chairman of Committee on Papers, and by Mr. Brewer, as Secretary-Treasurer. All of these gentlemen have worked with energy and devotion, and their efficiency has materially advanced the interests of the Association. They have my sincere thanks, and they are entitled to yours.

Gentlemen: In this, the annual address of your President, it has been my desire to be practical and helpful, and I have been plain in my observations and recommendations, and frank in my words of praise and frank in my criticisms.

The Suitability of Concrete for Gasholder Tanks.

[Prepared by MR. HERBERT W. ALRICH, Engineering Division, Consolidated Gas Company, New York.]

In its purpose the gasholder represents the common feature of all manufacturing enterprises—it is the receptacle for the storage of the product. But in their design, gasholders are not resembled by any structure or equipment employed in any other line of industry. A prominent engineering writer has recently said that the modern gasholder is "A magnificent achievement in engineering, and one of the wonders of it is the telescopic feature." As the majority of engineers are not familiar with the mechanical features of a gasholder, a description is given; for, in discussing tank design, it is necessary to consider the structure as a whole.

There are three principal parts to a gasholder: The tank, the telescopic sections or gasholder proper, and the guide frame. Each of these parts differs from the others in function and in the type of construction. The tank, resting upon the ground, is filled with water up to a level about 15 inches below the top. The gasholder proper consists of the telescopic sections, of which there are 5 in the case of the largest holders that have been built in this country. These sections consist of cylindrical steel shells, concentrically located with relation to each other and to the tank. When the holder contains no gas, these shells are nested together, resting upon the bottom of the tank and submerged almost completely in the water which the tank contains. See Fig. 1. The outermost shell is usually about 3 feet less in diameter than the tank, and each succeeding section is about 2 feet 9 inches less in diameter than the preceding one. All of the sections are open at each end, with the exception of the innermost

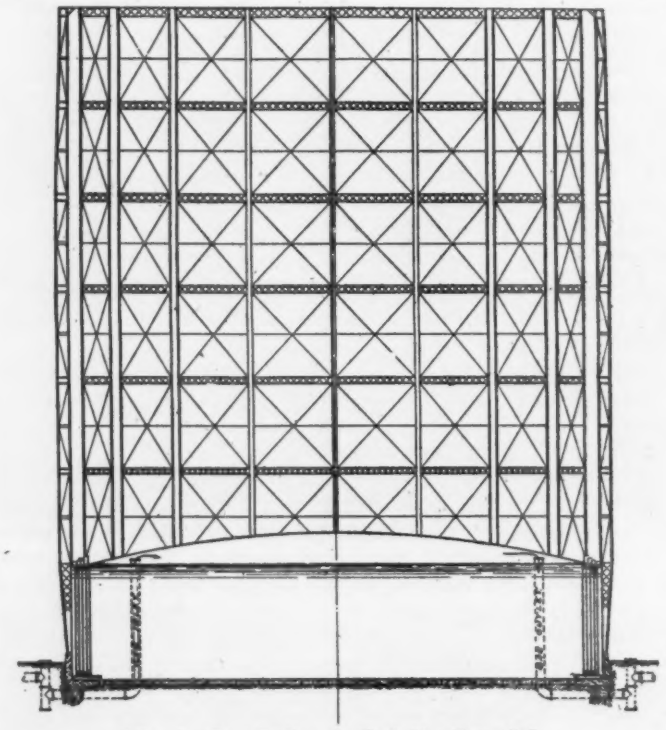

Fig. 1.—Cross Section of a Gasholder Grounded.

one, the upper end of which is inclosed by crown plating, having a spherical form.

The inlet and outlet pipe connections enter the tank through the bottom and pass vertically upward through the water and terminate at an elevation above the water and just under the crown of the inner section. When gas is admitted to the holder, it first acts upon the crown, lifting that section gradually out of the water, as shown by Fig. 2, until the cup, constructed around the lower edge of that

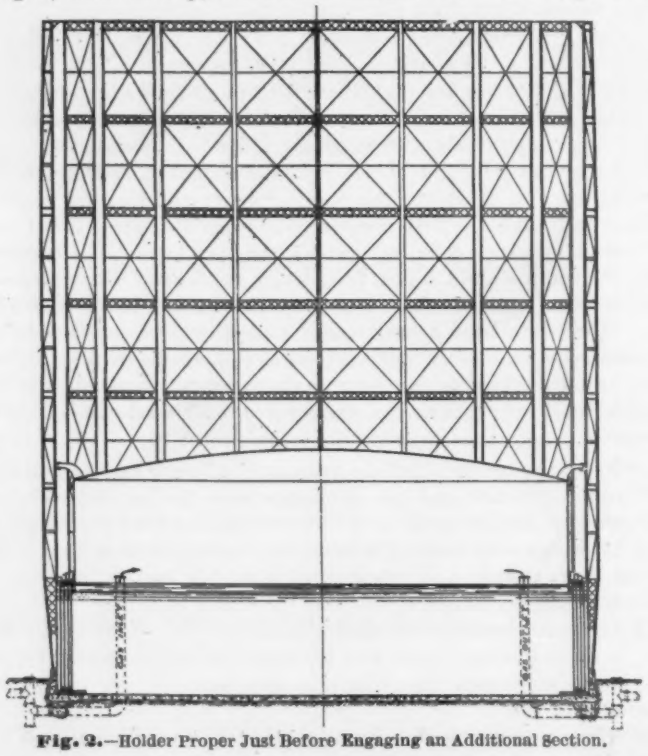

Fig. 2.—Holder Proper Just Before Engaging an Additional Section.

shell, engages the upper edge of the next outside section. To accomplish this engagement, the upper edge of each outer section is constructed in the form of a continuous annular hook, called the grip; and, correspondingly, the lower edge of each section, except the outermost one, is formed into a continuous annular cup. Both the grip and the cup are identical in construction, and differ only in the respect that the grip is inverted to permit interlocking with the cup, as shown in Fig. 3. As the inflation of the holder continues, each succeeding section is lifted out of the water, and in turn, picks up the next outer section. As each interlocked cup and grip pass upward out of the tank, there is carried along that quantity of water which is necessary for forming a hydraulic seal against the maximum pres-

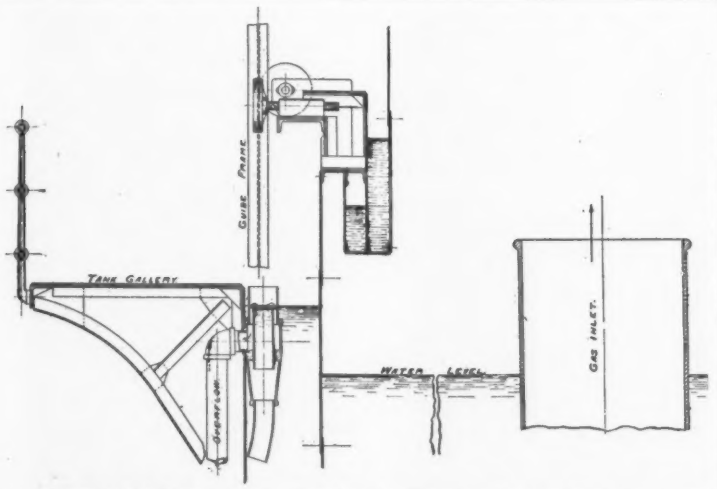

Fig. 3.—Detailed Cross Section. Showing the Hydraulic Seal between Two Outer Sections.

sure of the holder. This action continues until the holder is filled to the limit of its capacity, as shown by Fig. 4.

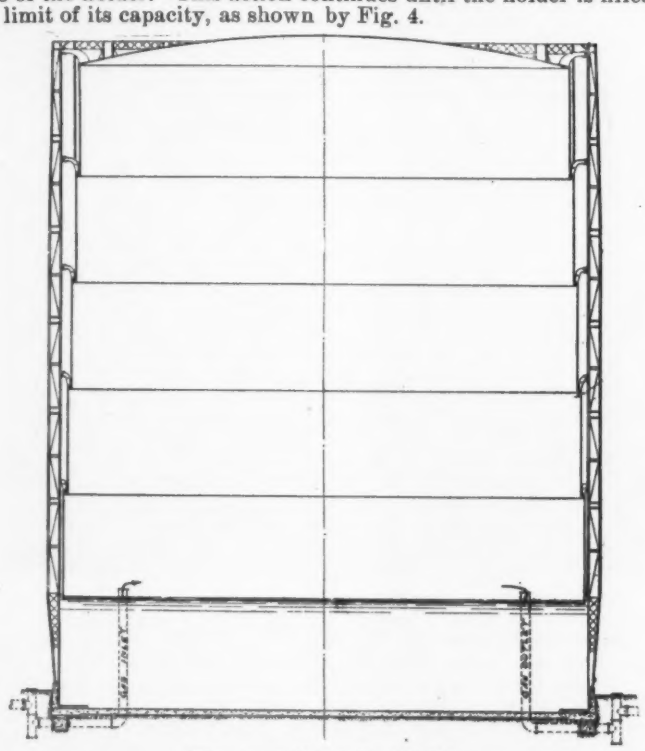

Fig. 4.—Holder Fully Inflated.

While thus ascending, or conversely descending, the sections are maintained in their relative concentric positions by 2 sets of rollers. First, the rollers spaced equidistant around the lower edges of the shells; and, second, the rollers mounted on brackets attached to the upper edges of the shells. The first is known as the internal rollers, and travel upon vertical guides, located on the inner surface of the tank and also on the inner surface of each shell, except that of the innermost section. The other set of rollers travels upon the guide rails, which are carried by the guide frame. The guide frame consists of vertical columns, spaced equidistant, and about 30 feet apart around the circumference of the tank. These columns are connected by horizontal and diagonal cross bracing. The frame is carried to such a height as will provide guidance for the inner section in its maximum upward travel. It will be apparent from this discussion that the enormous pressure of the wind against the inflated sections is ultimately transmitted by the guide frame to the tank.

In the selection of materials in manufacturing we are subject to an inexorable law of suitability. In producing any manufacture, there will be ultimately employed that material which possesses preponderating advantage. The use of any other cannot long be sustained. From the very beginning of the gas industry, 100 years ago, the guide frames and holder sections have been built exclusively of iron or steel. It does not appear that any attempt was ever made to use any other materials. In the construction of the tanks, however, many different materials and combinations of materials have been employed. It is true, however, that in this country, until recent years, all holder tanks were built either of brick or stone; but in England, the birthplace of the gas industry, there were constructed tanks of almost every conceivable type, many of the designs being more fanciful than practical. It was inevitable that those constructions without merit should disappear until the prevailing practice, throughout the world, during the last 20 years, may be stated as limited to steel tanks placed upon the ground, and brick or concrete tanks located below the ground. During the last 10 years the preponderance of advantage in this country has been in favor of steel tanks for all holders, large or small. In England, though concrete tanks had been constructed as far back as the year 1870, the practice of the last decade has been quite uniformly to build small tanks of steel, and large tanks of brick, there being but few instances of concrete construction. In Continental Europe, practice for a decade has followed the English, with the exception that during the last 3 or 4 years there has been a marked tendency toward the exclusive employment of steel, though a few concrete tanks of small size have also been constructed.

The competitive, economic and geological conditions existing in England all favor the brick tank for large holders. While the population of the Island of Great Britain is somewhat less than that of the United States, the number of concerns engaged in holder construction is very much greater; in fact, the building of the largest holders in this country is confined to a very few companies, having special qualifications and known responsibility. Hence the commercial conditions prevailing in this country have enabled these firms to develop extensive equipments, which have wonderfully facilitated the construction of steel tanks. When selecting sites for large holders in England, they appear to have generally encountered formations of clay possessing remarkable stability, This has permitted them to construct economical tanks by lining a cylindrical excavation in the clay with brick walls, which are thinner than our geological conditions will generally permit. Unskilled labor is relatively very cheap in England, and in some cases the cost of construction has been partly defrayed by the commercial value of the excavated clay. In the case of the 10,000,000 cubic foot holder, erected in Manchester in 1909 and 1910, the brick for the tank walls were manufactured upon the site from the excavated clay. It is a fact, however, that the time required for the construction of this particular holder would be regarded as economically impossible in the United States. The result of all of these conditions has been that the English holder builders have not developed the special equipment required for the construction of very large steel tanks, nor does it appear that the British steel plants produce plates suitable for the purpose.

To confine the discussion now to American conditions the controlling requirements in the design of a gasholder are:

1. Structural stability.
2. Economy.
3. Rapidity of construction.
4. Durability.

Certain physical phenomena having to do with the distribution of gas require the holders to be located upon the lowest available ground. In this country such sites rarely consist of a very stable geological formation, and are frequently reclaimed land. Hence, if under the usual conditions there be undertaken the construction of an underground masonry tank, there will probably be encountered such difficulties as to greatly enhance the cost of the work and prolong the period of construction. If it should be suggested that a concrete tank might be built above the ground, a moment's reflection upon its relation to the guide frame is sufficient to dispose of the proposition.

During the last 8 years the writer has participated in the design and construction of the 3 largest concrete holder tanks in the world. Two of these tanks are 300 feet in diameter by 48 feet 3 inches deep, while the third is 189 feet in diameter and 41 feet 6 inches deep, all inside dimensions. In referring to these particular tanks, and also throughout the discussion, he wishes to be understood as speaking for himself alone. The work on these three tanks proceeded in such simultaneous relation as permitted any improvement in methods developed on one, to be employed to advantage on another.

At the time the tanks were being designed, Mr. Wm. H. Bradley, Chief Engineer of the Consolidated Gas Company, of New York, made a thorough inquiry as to the design of concrete tanks that had been constructed anywhere in the world. There was found little precedence to consider. As regards the two 300-foot tanks, the undertaking was one of unusual magnitude, for the holders were the largest that had ever been built. The possibilities of nickel steel were not at that time fully understood, hence the construction of steel tanks would have been unthinkable, as there would have been required plates 4 inches thick, connected by rivets 3 inches in diameter. It was evident that masonry construction of some kind must be employed, A number of different designs were worked out, analyzed and compared, resulting in the conclusion that the most advantageous construction would be a plain, annular wall of reinforced concrete, and all 3 tanks were thus built. The work upon all 3 tanks was accomplished with entire success. While there were special conditions, the controlling factors in these instances, and determining the selection of concrete construction, the writer concludes that steel is far preferable as a general proposition. The smallest of these 3 tanks required a full year for its construction. An entire holder of the same size, having a steel tank, can be constructed in 7 months without special effort. It has also been demonstrated to the satisfaction of the writer, that in no case where a steel tank is at all possible will the cost reach 70 per cent. of the outlay required for a corresponding concrete construction.

The question as to whether steel or concrete tanks are the more durable, must be settled in another generation; but the writer believes that the steel tanks are the more expedient. He has knowledge of several brick tanks having been badly damaged by blasting in their vicinity. From his knowledge of other concrete structures, having been badly cracked in a similar way, he must conclude that concrete tanks are not immune from the hazard. The durability of concrete tanks is also open to question, in view of the peculiar behavior of concrete observed by the writer, in the instance of two of

(*Continued on page* 290.)

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NEW YORK, MONDAY, APRIL 29, 1912.

OBITUARY—JEREMIAH B. HOWARD.

Advanced in years it is true, and quite well on to the time period of life which prompted the Scriptural Historian to remark over the exceeding strength of those whose milestones along the highway of life number four score, it is nevertheless true that none of his contemporaries ever thought that to "Uncle Jerry" could the word "old" be properly applied. Bright, alert, active, and winsome he surely was a short month ago, and the portrait that goes with this simple narrative of his life's work, is a reproduction of one that was taken especially for the JOURNAL'S semi-centennial number of mid-summer, 1909. There he stands, in full illustration of his simple, winsome self. It was perhaps not meant for him to show prominently in gas engineering ranks, in so far as inventive genius, brilliant administrative or clever financing go; but none may truthfully challenge the statements that he was a capable director of men, a cautious and successful manager of gas works, and one whose ledger accounts ever showed a balance over the right side. Further, his fortune and fame were gained, not by rough-riding methods, nor by the curious, if not freakish, flashes of "executive ability" so often the sparking accompaniment of those whose advancement is of the order meteoric. Now, however, that he is returned to the earth from whence springs all life, his memory will be like unto the evergreen boughs that wave a dirge to him over his resting place in beautiful Linwood Cemetery, Dubuque, Ia. His death was due to an appopletic stroke that followed a slight stumble in his sleeping apartment, at his home in Galena, Ills., the night of April 9th.

Jeremiah B. Howard was born March 17, 1830, in Carrickfergus, County Antrim, Ireland, from which place his parents removed to New York city when he was less than a year old. They subsequently took residence in Brooklyn, and it was there that his tuition and first business experience were gained. His first business occupation was with a firm of steam fitters and plumbers, in a shop on Gold street, close to the Navy Yard (about 1844), and in time he became attached to the street main division of the Brooklyn Gas Light Company, during the Superintendency of that corporation by Mr. William H. Burnet. Active in habit and abounding in vitality, Mr. Howard joined the Fire Department (Volunteer) of Brooklyn, and was noted for his speed as a runner, when in charge of Mechanic Hose, No. II., the fire house of which organization adjoined the home of one of Brooklyn's earliest Mayors, the Hon. Burdette W. Stryker. In 1856 he journeyed to Dubuque, Ia., where he joined his brother (W. M. Howard) in the formation of a firm to engage in the gas and steam fitting business, with headquarters in the premises, Iowa and Sixth streets. New Orleans at that time seemed to offer great inducements to those engaged in the named business, and (the Dubuque attempt not proving signally successful) to that center of Louisiana trade Mr. Howard repaired. The Key City Gas Company, of Dubuque, was incorporated in 1856, and 2 years later he accepted the position of Superintendent thereto, and remained as such until 1891, save for a short period when Howard & McArthur operated the plant under leasehold from its virtual proprietor, the late Mr. J. K. Graves. His connection with gas works then was rather of sporadic sort, including brief periods spent in Brooklyn, N. Y., and Chicago, Ills. In 1893 (we believe) he became identified with the Galena (Ills.) Gas Light Company as Manager. Later on he became its President and Manager, and this trust he was actively carrying out when death claimed him. Mr. Howard was prominent in the work done by associated gas men, but particularly so in respect to the Western Gas Association, of which body he was really a charter member, although not regularly elected to the rolls until its second meeting (1879). He was its third President succeeding in that office the late Mr. Thomas Butter-

Born March 17, 1830.—Jeremiah B. Howard.—Died April 9, 1912.

worth, and served two terms (1883-84). His time and best thought were devoted to its advancement, and the writer well remembers how his fellow members esteemed him, when the Association's Swan Song was sung, at its 29th meeting (Cleveland, 1906), at which assemblage was taken the final action that caused its absorption as a part of the American Gas Institute, and this paragraph was incorporated in the final resolutions adopted:

"*Resolved*, We, recognizing that all societies and organizations are dependent largely upon the personality of some one who has impressed upon its members that which is a part of himself, accordly our oldest Past President, "Uncle Jerry" Howard, whom we all love, and who had the honor of twice serving as President during the formulative period of the Western Gas Association's history, that, by his most attractive personality, his warm and generous impulses, he drew friends to himself and the Association, who delighted in his companionship and deemed membership in the Association a privilege in every way beneficial. We are sure we voice the sentiments of every member of this Association when we express our love for him, and wish him and his many years of joy, health and contentment."

And to him this recognition of his worth was of exceeding value, for often has the writer heard him proudly refer to the wealth of affection that the sentences of the above resolution so beautifully carry. His other active affiliation was membership in the Illinois Gas Association, and one of the spryest, most interested attendants at its sessions last month was "Uncle Jerry."

Naturally Mr. Howard was prominent in the social and other personal relations that exist to so great an extent in the relatively smaller cities of our country, and both in Dubuque and Galena no other resident was more beloved—that is the proper word—than was "Uncle Jerry." To all he was known, by all he was cherished. He was very prominent in the Masonic circles of both, and to name his affiliation with bodies concerned in the welfare (or other matter) of home places would be like recapitulating the history and record of both Dubuque and Galena. The remains were removed to Dubuque, arriving there the morning of Friday, the 12th inst., under the escort of the Knights of Pythias, Appollo Orient Lodge, Dubuque and Saxon Lodge, Galena, and were placed in the Masonic Temple. Reposing there, in state, the body was viewed by hundreds, old and young, official and unofficial, rich and poor. The funeral service was held

according to the Masonic ritual, at 2 P.M. of the 12th, under the direction of Worshipful Master Bert, of Metropolitan Lodge; and the interment (later in Linwood Cemetery) services were conducted by the Masonic fraternity and the G. A. R. Right here it may be said that Mr. Howard was a veteran of the Civil War, having enlisted (1861) in the First Iowa Volunteer Infantry, and saw actual service in the bloody contest known as the battle of Wilson Creek, under General Lynn. For his part in this affair he was promoted to the post of First Lieutenant, Company A, 44th Iowa Volunteers. Mr. Howard was united in marriage (Brooklyn, N. Y., July 18, 1858) to Miss Mary E. Mercoun, of that city, and of this union the surviving children are: Mrs. E. P. Graves, Mrs. George M. Conway, Miss Fannie Howard and J. B. Howard, Jr. And so ends the story of a life well spent, the records of which show that its bearer had lived to nature, and had been rewarded by a career the evenness of which is as that of the stream that fructifies the soil without ravaging its confines. For matter in connection with this story we are indebted to the courteous attention of Mr. George McLean, of Dubuque.

BRIEFLY TOLD.

SECOND ANNUAL MEETING, NEW JERSEY STATE GAS ASSOCIATION.—The second annual meeting of the New Jersey State Gas Association was held Thursday April 25, 1912, at the Laurel House, Lakewood, N. J. President Pettes called the meeting to order shortly after noon, at which time over 25 members were present, and the number was doubled before the session closed. Routine matters considered included reports by Sec.-Treas., A. H. Osborn, which showed substantial increases in the membership and a good balance in the treasury. Mr. S. J. Franklin presented a report from the Nominating Committee, noting that, inasmuch as the Association was still in a formative period, it had been decided to name the present officers and directors for re-election, save that of Director B. M. Massey who was to be succeeded by Mr. C. W. Hoy. The Secretary was ordered to cast the ballot of the Association according to the instruction. The officers, therefore, are:

President—W. H. Pettes, Newark.
Vice-President—Chas. Butcher, Freehold.
Sec.-Treas.—A. H. Osborn, Belmar.
Directors—P. M. Satthwait, O. F. Potter, A. H. Reitmeyer, S. J. Franklin and C. W. Hoy.

The President, in his inaugural address, confined himself mainly to the commercial side of the industry, and strongly recommended the maintenance of residence as well as store lamps. He referred to the importance of selling campaigns, and suggested high pressure gas as one means of meeting gasoline competition. In discussing the address, Mr. J. P. Hanlan outlined the campaign conducted by the Public Service Gas Company on residence lighting, a result of which showed some 60,000 burners being placed in use. Others sharing the discussion were Messrs. Conroy, Brock, Franklin and Gribbel. Thereupon the business session was declared closed and the members adjourned for luncheon. In place of set papers the officers were fortunate in securing a Jerseyman of national fame to address them. Immediately after luncheon President Pettes introduced ex-Governor Stokes, whose theme mainly concerned the relation between public utilities and the public, and his presentment could be studied to great advantage by public men both within or without the industry. His pithy statements were greatly accentuated by an eloquent delivery. As no business session was scheduled for the afternoon, many of the members attended the polo game at beautiful Georgian Court, the home of the senior Gould.

CLOSING SCENES, GAS CENTENARY.—The final morning session (Friday, the 19th) was commenced at 10. Mr. Cortelyou read an address on "The Commercial and Financial Aspects of the Gas Industry," and it is regrettable that one half its matter had to do with the historical side, thus leaving scant time for mention of the financial section of the industry, as to which side he is beyond doubt qualified to speak in most interesting way. The next number, "The Technique of Gas Manufacture," was read by Mr. A. E. Forstall, who, at the outset, stated quite to the point that, as the previous speaker had fully covered the historical part, he would forego presenting the introductory pages of his matter. As its text had mainly to do with carbureted water gas, the title selected by the author would seem to be better descriptive had it been something else than it was. As it was, however, as a brochure in water gas, *per se*, it was certainly meritorious. The Forstall compendium at an end, the Chairman then introduced Mr. Davis, who, as the "oldest living gas engineer," was presented to the assemblage. He was loudly cheered at the outset, and then went on to say that he had helped to build the Troy (N. Y.) works in 1848. The veteran was certainly in excellent physical condition, and no other one present was a closer observer of all that was done than was Mr. Davis. Responding to a somewhat general request, those present who were connected with the gas industry for at least 30 years were invited to stand up for inspection. And the proceeding seemed rather out-of-line. However, 17 responded, prominent amongst whom were Chief W. H. Bradley, Geo. G. Ramsdell F. Egner and D. J. Collins. Regarding the latter, someone in a stage whisper remarked that he didn't think "D. J." was even 30! Here the United Gas Improvement Company assumed charge and escorted those present to the restaurant on the roof of the Continental Hotel, where a well-prepared, acceptably served luncheon was enjoyed. The afternoon session was resumed at 2:45. Mr. Van R. Lansingh read a well-balanced paper on "Gas as an Illuminant," and the session was closed by a forceful series of chapters, put together by Dr. Rosa, whose composite theme was "The Use of Gas for Heat and Power: The Testing of Gas." The communication was an excellent one, and closely held the attention of everyone present. After a few pleasant words from General Dodge (the presiding officer), adjournment was taken.—W.

THE CLOSE OF THE SOUTHERN GAS ASSOCIATION MEETING.—"E. D. B.," our special correspondent in respect of the meeting of the Southern Gas Association in Florida in mid-April, writing "A day or so after the Fair," remarks: I overlooked one thing in connection with the social features of the meeting, and that was the entertainment furnished the members on the boat trip, which was mainly chargeable to Mr. W. S. Guitteau, of the Lloyd Construction Company, Mr. John F. Parker, of Rockford, Ills., Mr. Chas. Harbison and Mr. Chas. Richardson. Parker's melodious voice, accompanied by Richardson at the piano, kept everybody in good humor with his melodies. Guitteau and Harbison, with their fake fight and merry mesmerizing act, had a good many of them guessing. The entertainment was all right.

CURRENT MENTION—

AT the annual meeting of the stockholders in the Joseph Dixon Crucible Company, hold at the Company's main office, Jersey City, N. J., mid-April, the retiring Board of Directors (comprising Messrs. George T. Smith, William Murray, Edward L. Young, Wm. H. Corbin, Geo. E. Long, W. G. Bumstead and Harry Daily), was unanimously re-elected. There were votes on 9,304 shares out of a total of 10,000, so it will be seen that many shareholders personally attended the meeting. They all expressed themselves well pleased with the Company's showing and as to its immediate prospects. The Directors perfected the following organization of the Board: President, G. T. Smith; Vice-President, W. H. Corbin; Treasurer, Geo. E. Long; Secretary, "Harry" Dailey; Asst. Treas. and Sec., J. H. Schermerhorn.

ON the 24th inst. a special meeting of the shareholders of the Edison Electric Illuminating Company, of Boston, Mass., was held to authorize the purchase, subject to the approval of the Massachusetts Board of Gas and Electric Light Commissioners, of the franchises, locations, etc., of the Hyde Park and the Weston Electric Light Companies; also, to authorize additional capital stock for purpose of realizing funds to be applied to the payment of liabilities heretofore or hereafter incurred for additions to and extensions of the plant and property of the corporation. Assent to the proposition was given.

The Southern Gas Association in Readiness for the Boat Ride to Mayport, where a Shore Dinner was Served.

(*Continued from p. 287.*)

the most prominent engineering undertakings in the United States, in which cases, several years after the concrete had set, masses of it became soft and pulpy, requiring replacement. A holder tank is not such a structure as one upon which such repairs can be easily made, but it is one of such importance as to forbid speculative constructions.

The writer has examined and reported upon a large number of steel tanks, some of which had been in service for over 20 years. While these older tanks are doubtless constructed of a steel far inferior to that now produced, all of these tanks, with one exception, could survive the youngest man now engaged in the gas business. It has sometimes been urged against the durability of steel tanks, that all favorable conclusions had been formed from exterior examinations. The writer has had the opportunity of closely examining internally some of the oldest steel tanks in existence, through which he concludes that, excepting at the water line, there is no perceptible deterioration. In one case, the holder had been employed for 12 years, in connection with a process of gas manufacture now obsolete. As a part of this process, a non-luminous gas, containing some sulphur was stored in this holder, which resulted in the sulphur being absorbed by the water in the tank. The writer found the interior of this tank to be but very slightly pitted.

The writer would state it as his conviction, that, while not possessing one single element of advantage over steel tanks, that concrete tanks are subject to the following comparative disadvantages:

1. Increased cost, generally 75 per cent.
2. Longer period required for construction, generally 100 per cent. for the entire holder.
3. Liability to impairment from unforeseen or unavoidable causes, such as internal stresses, bad water, oil or alkaline soil and blasting.
4. Difficulty of making repairs and obtaining the original strength in case of rupture.
5. Possibility of corrosion on reinforcement, the vital element of the tank's strength.
6. Inaccessibility of metal to inspection.
7. Greater load on foundations.
8. Requires the most rigid inspection and supervision to control the quality of the work during construction.
9. Liability to serious difficulties from storms during construction, due to the depth of excavation, the requirement of maintaining adjacent streets, requiring sheet piling 50 feet deep and massive shoring timbers. Also, liability of damage to the concrete work itself from the same cause.

In submitting a discussion of this question to the American Gas Institute, in 1910, the writer urged the following as the 12 distinct advantages of steel tanks when compared with those of masonry:

1. Less cost.
2. Shorter period required for construction.
3. The ease with which the quality of the work may be controlled during construction.
4. The high state of development in fabrication and erection.
5. Susceptibility to exact computation and greater reliability under stress.
6. Accessibility for inspection.
7. Tank may be placed at any elevation with relation to the ground line that may be desired.
8. No liability to damage by storm during construction.
9. No internal stresses from shrinkages or temperatures that are serious.
10. Possibility of rectifying an unequal settlement.
11. No liability to cracking from undetermined causes.
12. The ease of making repairs and obtaining the original strength.

Everyone of the enumerated disadvantages of concrete tanks, and advantages of steel tanks, might be separately extended and elaborated; but the writer will confine himself to items 2 and 4 under steel tanks.

The bottom of a steel tank, excepting an outer course, consists of rectangular steel plates, generally about $\frac{3}{8}$ of an inch thick, connected by single riveted lap joints. The outer course consists of heavy segmental plates, which conform the bottom to the circle. Riveted around the outer edge of this outer course, in the bottom curb, which, in the case of a large tank, will be an 8 inches by 8 inches by $1\frac{1}{2}$ inches angle. The bottom course of curved plates, forming the shell of the tank, is riveted to the upstanding leg of this curb angle. The next course of plating is then attached to the lowest course by a single riveted lap joint running horizontally around the tank circumference. The other courses are connected in a similar manner, the entire number in the height of the tank usually being about 8 or 9. It is necessary for the vertical joints, which occur about 30 feet apart around the circumference, to be spliced in a manner capable of resisting the full circumferential tension. To accomplish this, the joints are covered by double butt straps, each tuch splice being quadruple riveted with double shear rivets, and triple riveted with single shear rivets. The total number of rivets, in the cylindrical shell of the tank alone, may be as many as 25,000.

After the bottom of the tank has been completed, a vertical steel post is erected at its geometric center. A circular rail is also laid concentrically upon the tank bottom. Mounted upon trunnions, upon the top of the central steel posts, are two radial traveller arms, the outer ends of which are supported by legs having wheels running upon the circular rail. These radial travellers are equipped with such suitable attachments, as will permit one of them to be used for assembling the curved plates while the other supports the hydraulic-pneumatic riveting machine. Thus, as one traveller proceeds around the circumference lifting the plates into position, it is followed by the other with the rivets. Quite obviously, the first traveller is able to keep well ahead of the riveting, which permits that traveller to participate in the simultaneous erection of the 5 holder shells. When the tank and the holder section have been completed, the tall center post, around which the travellers revolve, is replaced by a much shorter one, resting upon the center of the crown. While the outer leg of one of the travellers has its lower section removed, and thus shortened, it travels upon a circular rail which has been attached to the completed crown. The other radial traveller is entirely removed. After water has been placed in the tank, the holder is gradually inflated with air, and as it rises the remaining radial traveller moves around the circumference, erecting the guide frame successively in tiers. It requires but little reflection to perceive that, if the holder is to be provided with a concrete tank, any such co-ordination is impossible. As to the time required, it may be stated that in the instance of the largest steel tanks ever built, which were 251 feet 3 inches in diameter, the lower courses of which consisted of $2\frac{5}{16}$-inch plates, and having 26 double-butt joints in each course, the tanks were erected and riveted complete at the rate of 32 hours per course. One of these holders was entirely completed in $7\frac{1}{2}$ months. If there be a method of concrete tank construction which would have permitted the completion of that same holder in 2 years, it has not yet been found.

In closing, the writer will condense into a few words his opinion on the matter, as stated in another discussion: "He may be charged with entertaining a strong prejudice against masonry tanks. He will admit that he is opposed to any type of tank, 25 to 40 per cent. of the cost of which may go into digging a hole in the ground instead of putting quality into the structure." To this he would add his conviction that a site which forbids a steel tank is not the place to put a holder.

(Continued from page 276.)

Flow of Gas Formulæ, Derived, Analyzed and Checked by Experimental Data, with Diagrams for Figuring the Flow of Gas in Street Mains and Services.

[Prepared by Mr. J. M. Spitzglass, for the Eighth Meeting, Illinois Gas Association.]

(18.) Formulæ Checked by Experimental Data.

Plates Nos. 1, 2 and 3, and Table No. 1 show the method by which the given formulæ were compared with the experimental data. The table contains some of the data of the tests, and all the figures plotted on the plates. The work was much simplified, and a great deal of figuring was avoided by considering directly the co-efficient of discharge (the ratio of the quantity delivered) to the combined value of all the known factors involved in the delivery. If this combined value, which is represented by the radical of the formula, shall be plotted against the theoretical quantity, assuming the co-efficient of discharge C to be a constant number, the points would necessarily follow a straight line representing by its slope towards the base the numerical value of the constant C. In this case the experimental quantity was plotted against the corresponding value of the radical, in order to observe the constancy of C, and to determine its numerical value.

The points on each curve were plotted on a sliding scale in the multiples of 1, according to the magnitude of the numbers. The same scale, however, was used in each case for the quantity and the corresponding radical. In the case of high pressure data the radical was divided by 0.73 (0.73 being the ratio of C_2 to C_1 in equation 19) in order to keep the same proportionality on the curves.

Referring to Plate 1, which represents the relation of the experimental discharge to the radical of equation 19, or Pole's formula, we see that the points are scattered in a way to make the co-efficient increase considerably with the diameter of the pipe. Dr. Pole's value of 1350 shows a fair average on the diagram, but the variation on both sides is too large to take the average into consideration. It simply means that C must be varied, from 1,100 for small sizes to 1,580 for large pipes.

The second Plate, plotted in the same way, represents equation (20) deduced from Unwin's formula. The points on this plate are much closer to the average, but most of the large sizes are on the lower side of the average line, while the value of 1,700, deduced from Unwin's figures, is practically the maximum curve on the Plate.

The formula proposed by the writer (or equation 26) is shown on Plate 3. In this case the points are as close to the average as experimental results can be expected, taking into consideration the variety of circumstances. The line for the average value of C shows 2,050 (as given in equation 27) indicating that Unwin's co-efficient is applicable to diameters close to 12 inches only, while the writer's equation, being equivalent to Unwin's for a 12-inch pipe, holds fairly true for all other sizes also.

(19.) The Graphical Solution of the Formulæ.

Equations (26) and (27) however simple they are, require a considerable amount of figuring for their solution when the case is presented. If the quantity is one of the given factors in the problem the form for the solution of the diameter becomes a little complicated by having the latter in two different powers, the first and the fifth. Still another form is necesary to solve for the drop of pressure when all other factors are givsn.

To eliminate this figuring, the writer designed a set of diagrams, or charts, a reduced copy of which is presented in this paper, for the graphical solution of these equations in all possible forms. In fact,

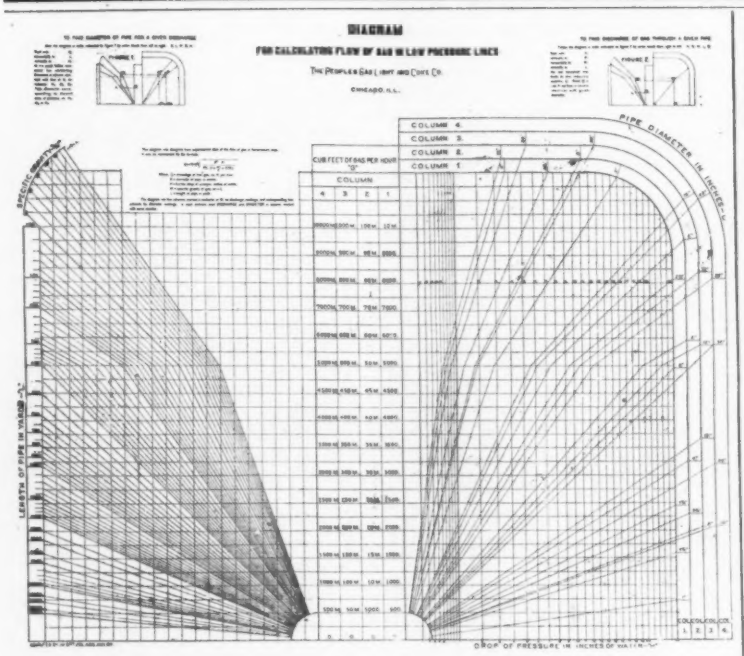


TABLE I

Experimental Data and Figures Plotted on Plate No. 1 & 2.

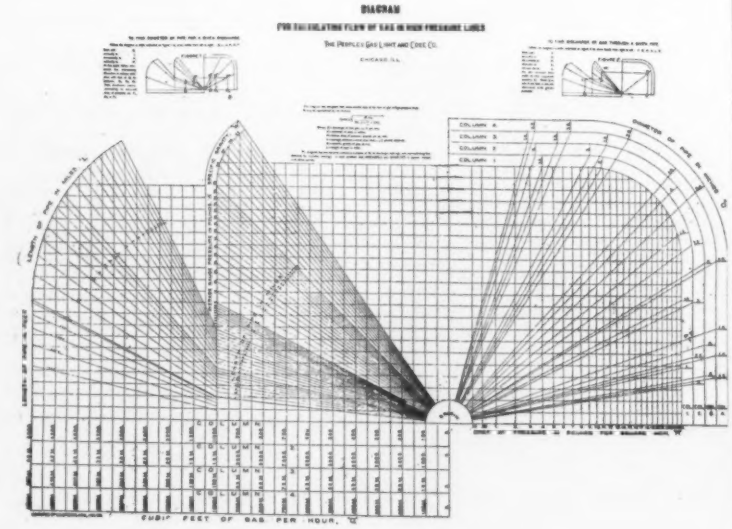
Low Pressure

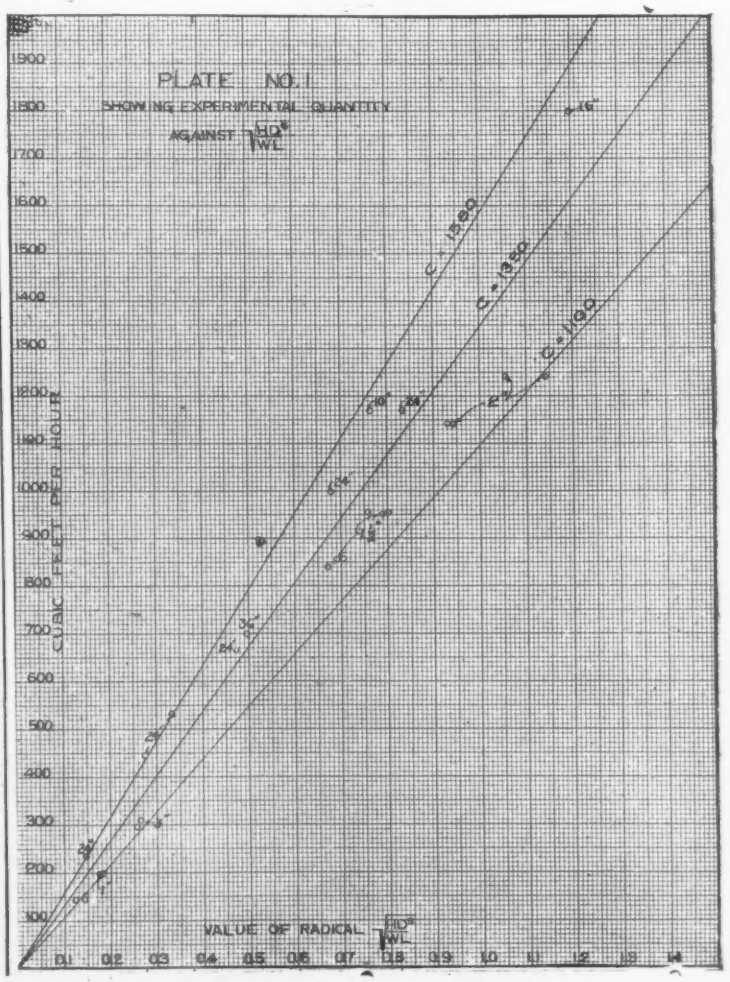
No.	Diameter (Nominal) D	Length Yards L	Initial Pres. Inches Wat. H_0	Final Pres. Inches H_1	Drop (H₀ − H₁) H	Specific Gravity W	Discharge at 60° & 30" Bar. Q	$\frac{D^5H}{WL}$	$\frac{D^5H}{WL}\left(\frac{1}{D}+\frac{3.6}{D^2}\right)$	$\sqrt{\frac{D^5H}{WL}\left(\frac{1}{D}+\frac{3.6}{D^2}\right)}$
1	½	20.3	3.705	3.61	0.17	0.599	198	0.1763	0.27758	0.52782
2	¾	40.7	3.92	3.81	0.111	0.599	198	0.1763	0.27758	0.52782
3	1	20.3	3.75	3.62	0.134	0.599	198	0.1273	0.2188	0.4677
4	1	40.7	3.83	3.69	0.14	0.599	196	0.1261	0.2165	0.4653
5	1½	20.3	3.93	3.84	0.09	0.596	369	0.1270	0.4083	0.6390
6	1½	40.0	3.78	3.60	0.18	0.596	363	0.1215	0.4089	0.6397
7	1½	20.3	3.93	3.85	0.08	0.596	364	0.1270	0.4083	0.6390
8	1½	40.0	3.86	3.67	0.193	0.596	359	0.1261	0.4052	0.6365
9	1½	20.0	3.93	3.84	0.09	0.596	364	0.1270	0.4071	0.6377
10	1½	20.0	3.96	3.78	0.18	0.596	363	0.1260	0.4046	0.6361
11	2	20.0	3.87	3.73	0.140	0.590	744	0.1263	0.4089	0.6394
12	2	20.0	3.87	3.72	0.150	0.590	744	0.1263	0.4089	0.6394
13	2	20.5	3.91	3.77	0.140	0.590	744	0.1263	0.4089	0.6394
14	2	40.5	3.92	3.72	0.200	0.590	729	0.1236	0.4000	0.6325
15	3	20.5	3.89	3.85	0.040	0.590	1499	0.1270	0.4109	0.6410
16	3	20.5	3.86	3.71	0.150	0.590	1470	0.1245	0.4029	0.6348
17	4	20.5	3.89	3.85	0.040	0.590	2983	0.1262	0.4083	0.6390
18	4	20.5	3.86	3.71	0.150	0.590	2929	0.1239	0.4009	0.6331
19	4	40.5	3.89	3.74	0.150	0.590	2929	0.1239	0.4009	0.6331
20	4	40.5	3.89	3.74	0.150	0.590	2929	0.1239	0.4009	0.6331

High Pressure

	Diameter Inches D	Length Yards L	Initial Pres. Lbs. Above Atm. P_0	Final Pres. Lbs. Above Atm. P_1	Drop Pressure Lbs. $P_0^2 - P_1^2$	Specific Gravity W	Discharge of Dry Gas at 60° Q	$\frac{1}{D^{5.31}}\sqrt{\frac{PDA}{WL}}$	$\frac{1}{D^{5.31}}\sqrt{\frac{PDA}{WL\left(1+\frac{3.6}{D}\right)}}$	$\frac{1}{D^{5.31}}\sqrt{\frac{PDA}{WL\left(1+\frac{3.6}{D}\right)}}$
22	½	1320	18.7	16.7	70	0.65	172000	74.2	70.5	59.1
23	¾	3960	18.7	16.7	70	0.65	166000	77.7	73	61
24	1	1320	18.7	16.7	70	0.65	334000	397	372	264
25	1	3960	18.7	16.7	70	0.65	322000	383	359	255

Note: $\frac{D^5H}{WL}$ in the numerator of the last member is the high pressure formula in the radical. (Reyer, p. 10 Edition 16) $A = \frac{1}{2}(A_1 + A_2)$.





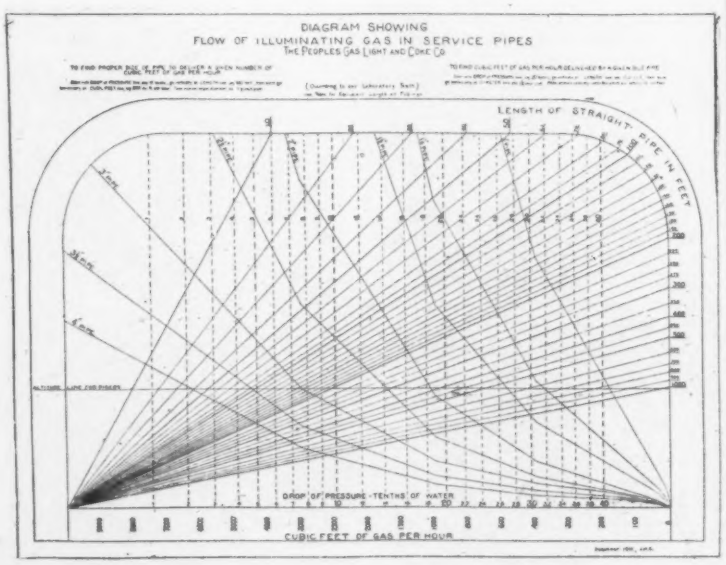


DIAGRAM SHOWING
FLOW OF ILLUMINATING GAS IN SERVICE PIPES
THE PEOPLES GAS LIGHT AND COKE CO
LENGTH OF STRAIGHT PIPE IN FEET
DROP OF PRESSURE - TENTHS OF WATER
CUBIC FEET OF GAS PER HOUR

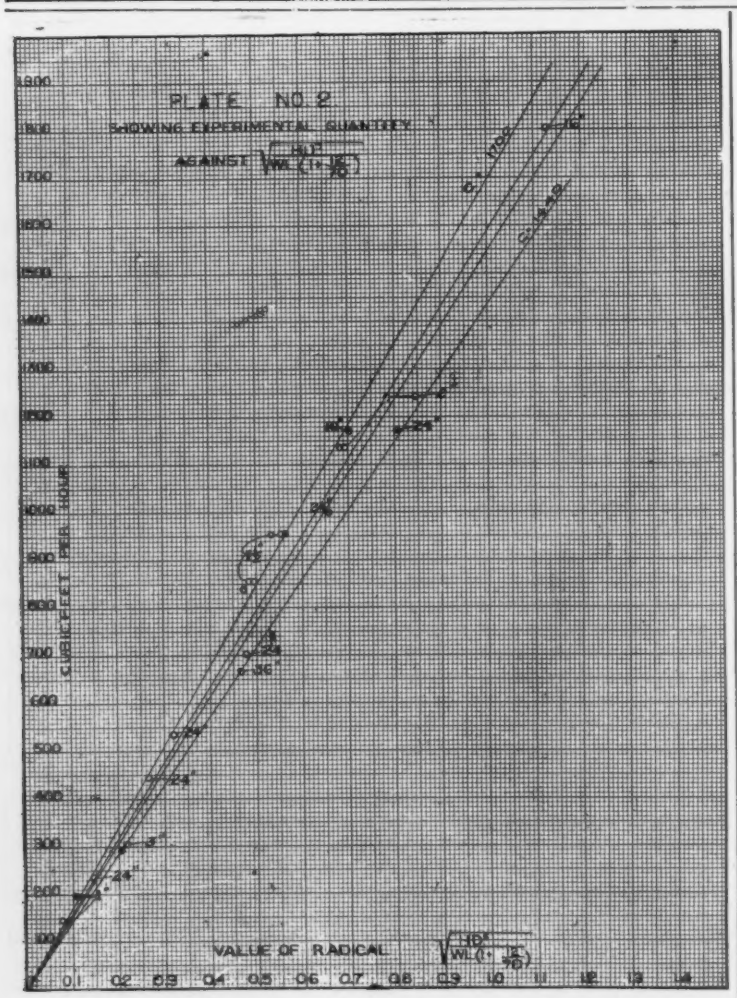


PLATE NO. 2
SHOWING EXPERIMENTAL QUANTITY
AGAINST $\sqrt{\frac{H D^5}{WL\left(1+\frac{15}{D}\right)}}$
CUBIC FEET PER HOUR
VALUE OF RADICAL $\sqrt{\frac{H D^5}{WL\left(1+\frac{15}{D}\right)}}$
0 01 02 03 04 05 06 07 08 09 10 11 12 13 14

TABLE 2

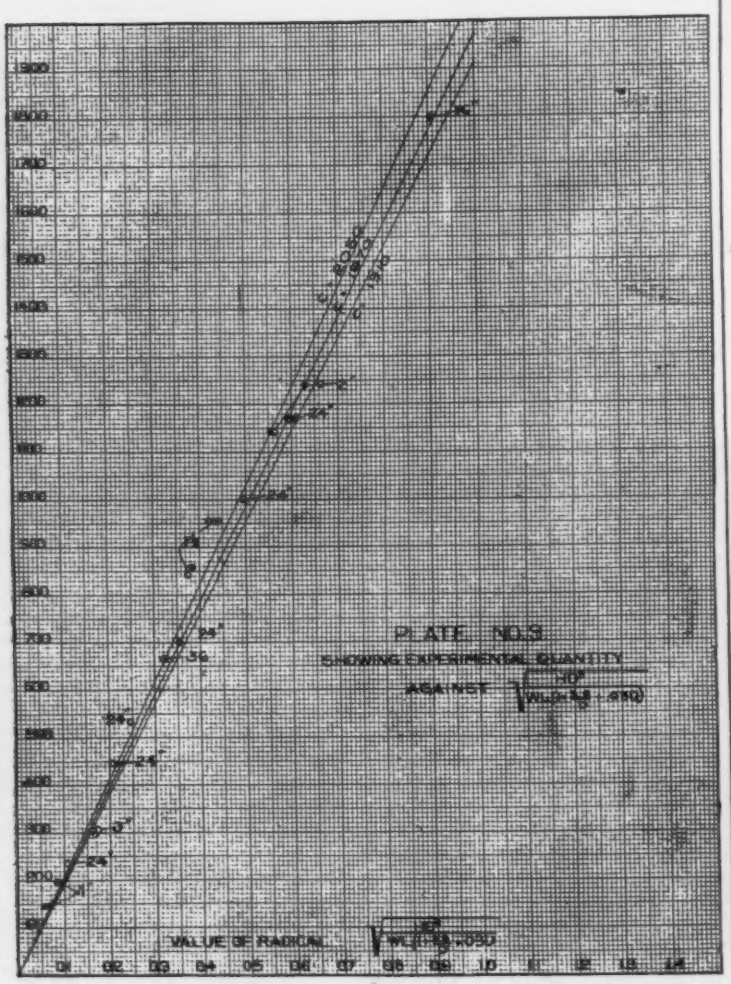
Discharge of Pipes from the Solution of Pole's and Unwin's Formulae Compared to Solution from Diagrams

Size	Diagrams $Q=1910\sqrt{\frac{D^5H}{WL\left(1+\frac{33}{D}+.030\right)}}$ and $Q=1910\sqrt{\frac{\left(\frac{D^2+R^2}{2}\right)^2 D^5}{WL\left(1+\frac{33}{D}+.030\right)}}$	Pole's Formula $Q=1350\sqrt{\frac{D^5H}{WL}}$	Unwin's Formula $Q=1625\sqrt{\frac{\left(R^2-\frac{R^3}{3D}\right)D^5}{WL\left(1+\frac{33}{D}\right)}}$
1/4"	100	150	114
1/2"	100	125	109.
1/4"	100	128	107.
2"	100	118	106.
2 1/2"	100	112.5	104.
3"	100	106	102.5
3 1/2"	100	103	102.
4"	100	100	101.5
5"	100	97	100.5
6"	100	94.5	100.5
8"	100	92.	100.5
10"	100	91.	101.
12"	100	91.	102.
14"	100	91.5	104
16"	100	92.5	105.5
20"	100	94.5	108
24"	100	97.5	112
30"	100	100.5	117.5
36"	100	104.5	122.5
42	100	108.5	127.5

TABLE 3

Length of Straight Pipe in feet Equivalent to one standard Elbow

Diameter in Inches	Length in feet	Diameter in inches	Length in feet	Diameter in inches	Length in feet	Diameter in inches	Length in feet
1	1.65	3	9.3	8	32	20	77
1 1/4	2.6	3 1/2	11.5	10	42	24	88
1 1/2	3.3	4	14	12	49	30	102
2	5.1	5	19	14	57	36	112
2 1/2	6.7	6	24	16	63	42	122



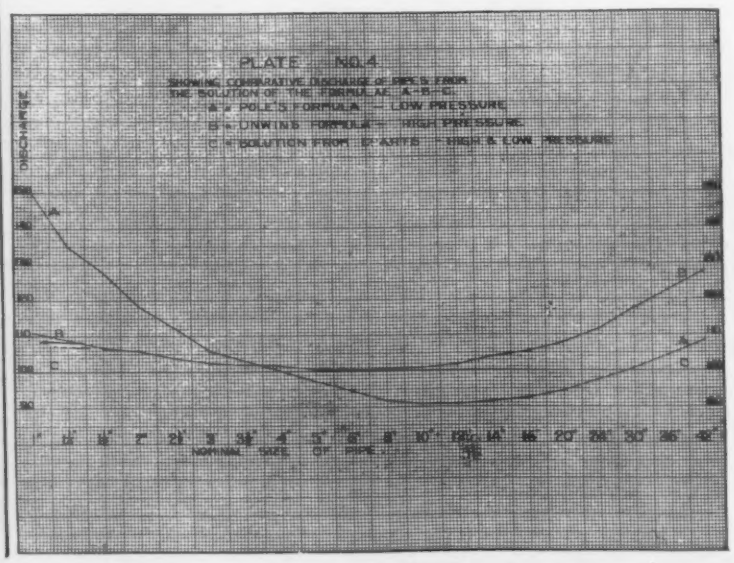


PLATE NO. 4
SHOWING COMPARATIVE DISCHARGE OF PIPES FROM THE SOLUTION OF THE FORMULAE A+B+C
A = POLE'S FORMULA — LOW PRESSURE
B = UNWIN'S FORMULA — HIGH PRESSURE
C = SOLUTION FROM DIAGRAMS — HIGH & LOW PRESSURE
DISCHARGE
NOMINAL SIZE OF PIPE

THE PEOPLES GAS LIGHT AND COKE CO CHICAGO ILL.

TABLE 4

EQUATION OF PIPES – DIAMETERS AND LENGTHS

BORE SIZE	½"	¾"	1"	1¼"	1½"	2"	2½"	3"	3½"	4"	5"	6"	8"	10"	12"	14"	16"	20"	24"	30"	36"	42"
½	1.0	6.19	20.7	99.6	246	985	2440															
¾	2.36	1.0	4.22	19.9	46.7	191	513	1704														
1	4.8	2.0	1.0	4.8	11.6	47.5	127.5	429	929	1857												
1¼	10.0	4.4	2.2	1.0	2.41	9.88	26.5	88	193	385.5	1278	3385										
1½	15.5	6.8	3.4	1.5	1.0	4.1	11.	36.5	80	159.5	530	1400	5820									
2	31.4	13.8	6.9	3.1	2.0	1.0	2.68	8.9	1254	34.1	130	3426	1420	4850								
2½	51.8	22.6	11.6	5.1	3.3	1.6	1.0	3.32	7.28	14.53	48.5	1225	930	1700	4150	8865						
3	93.8	41.3	20.6	9.4	6.0	3.0	1.8	1.0	2.2	4.38	14.53	3846	160	503	1250	2675	5120					
3½	139.0	61.2	31.5	13.8	8.9	4.4	2.7	1.48	1.0	2.0	662	17.82	72.8	230	569	1218	2331	6929				
4		86.5	43.2	19.6	12.6	6.2	3.8	2.10	1.4	1.0	3.32	8.7	36.5	116	285	610	1170	3420	8100			
5		157.0	78.3	35.8	22.9	11.4	6.9	3.8	2.6	1.8	1.0	2.63	11.8	35	86	184	352	1030	2443	6900		
6			128.0	58.2	37.5	18.6	11.5	6.2	4.2	3.0	1.6	1.0	4.18	13.3	32.9	70	134.5	393	931	2625	6060	
8				118.4	76.3	37.8	23.0	12.6	8.5	6.0	3.3	2.0	1.0	3.18	7.82	16.79	32.1	93.8	234.5	627	1449	2905
10					134.0	67.5	41.1	22.5	15.2	10.7	5.9	3.6	1.8	1.0	2.46	5.28	10.1	29.6	70	198	456	915
12						108.5	66.2	36.4	23.9	16.9	9.3	5.7	2.8	1.6	1.0	2.19	4.1	11.98	28.6	80.1	189	371
14						134.3	96.1	51.7	34.9	24.6	13.5	8.3	4.1	2.3	1.5	1.0	1.93	5.61	13.38	37.5	86.5	173.5
16						214.0	130.5	71.6	48.4	34.4	18.8	11.8	5.8	3.2	2.0	1.4	1.0	2.92	6.93	19.55	48.1	91.2
20						368.0	222.5	122.3	82.6	58.4	32.1	19.7	9.7	5.4	3.3	2.4	1.7	1.0	2.37	6.69	15.61	30.3
24						542.0	343.0	188.0	127.0	90.0	49.5	30.2	14.9	8.4	5.3	3.6	2.6	1.5	1.0	2.82	6.51	13.1
30						948.0	577.0	317.0	215.5	151.0	85.0	51.0	25.0	14.0	9.0	6.1	4.4	2.6	1.7	1.0	2.31	4.65
36						1435	876.0	480.0	324.0	230.0	126.0	77.5	38.0	21.4	13.6	9.3	6.7	3.9	2.5	1.5	1.0	2.01
42						2035	1242	680.0	460.0	326.0	179.0	109.5	54.0	30.3	19.3	13.2	9.5	5.6	3.6	2.2	1.4	1.0

NOTE: LOWER HALF SHOWS EQUIVALENT NUMBER OF PIPES - UPPER HALF - RATIO OF LENGTH FOR THE SAME CAPACITY.

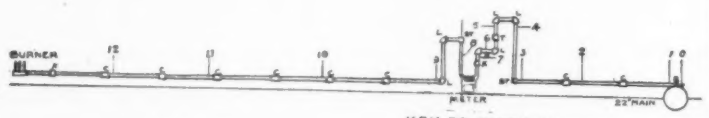


FIGURE 1

SHOWING POSITIONS OF GAUGES AND CONNECTIONS

KEY TO FITTINGS

C	COUPLING	ST	STREET TEE
S	STREET ELL	T	TEE
L	ELBOW	K	SERVICE COCK

TABLE 5

AVERAGE DATA AND FIGURES OF TESTS ON ——— 1-INCH STD. PIPE

TEST NUMBER	WITHOUT ELBOWS						WITH ELBOWS				
	1F-1	1F-2	1F-3	1F-4	1F-5	1F-6	1E-1	1E-2	1E-3	1E-4	1E-5
DATE OF TEST	6-23-11		6-26-11			-	6-22-11				
TEMPERATURE OF GAS AT METER °F.	106	106	91	92	91	91	101	100	97	98	98
BAROMETRIC PRESSURE, INCH. MERC.	29.41	-	29.31	-	-	-	29.50				
MAIN PRESSURE, INCH. WATER	6.00	6.07	6.12	5.36	5.11	5.00	5.60	5.94	5.98	4.12	4.02
SPECIFIC GRAVITY OF GAS	.6950	-		-	-	-	.6915	-			
DISCHARGE, CUB.FT. PER HOUR	213	189	134	93	93.5	156.9	200	148.5	99	257	62
" " CORR. FOR STD. COND.	196		146			149	186	137.5		240	
VELOCITY THRU PIPE, FT. PER SEC.	9.9		7.15			7.27	9.3	6.91		12.	

DROP IN INCHES OF WATER AND PERCENT OF TOTAL DROP FOR EACH MANOMETER ON THE LINE	NUMBER	DISTANCE FROM MAIN	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT	INCHES	PER CENT
	1	1.1'	.02	2.5	.02	2.5	.04	3.6	.01	2.13	.01	2.9	.02	1.9	.03	1.8	.05	3.1	.015	3.1	.02	3.1	.02	3.1
	2	43.8	.31	38.2	.19	17.6	.19	17.6	.08	11.	.08	11.9	.09	5.3	.04	2.3	.09	5.1	.035	4.2	.01	1.5	.02	2.5
	3	62.1'	.37	32.0	.19	17.6	.09	8.3	.03	3.13	.03	4.28	.10	15.1	.13	17.7	.13	13.2	.04	6.3	.04	12.3	.04	10.3
	4	66.'	.31	25.8	.34	46.0	.23	21.3	.05	15.6	.03	25.2	.20	30.6	.05	26.2	.11	21.4	.04	6.3	.06	25.5	.01	3.4
	5	67.3'	.19	31.3	.34	46.0	.15	21.3	.11	33.3	.14	44.	.20	33.5	.04	23.6	.13	23.6	.05	10.4	.10	23.6	.01	3.4
	6	68.6'	.31	20.5	.11	24.7	.15	23.7	.05	16.9	.04	9.0	.30	25.5	.05	23.2	.15	25.5	.03	4.2	.14	33.2	.04	7.1
	7	69.4	.19	26.5	.20	23.5	.23	29.7	.04	13.	.04	6.8	.23	20.4	.03	23.6	.15	25.5	.03	4.2	.16	29.3	0	0
	8	73.2	.38	23.3	.20	23.5	.40	36.	.04	6.7	.10	23.6	.36	34.3	.27	46.	.27	33.7	.13	22.1	.13	51.7	.15	64.4
	9	78.8	.36	24.1	.40	36.1	.61	55.	.19	30.2	.20	32.4	.55	52.3	.85	53.	.40	44.9	.22	45.3	.02	5.7	.15	53.6
	10	120.3	.48	53.1	.18	6.6	.80	72.	.31	47.4	.27	72.2	.70	70.5	.04	6.6	.34	95.2	.25	51.	.11	65.5	.14	50.
	11	141.2	.130	39.5	.38	9.4	.98	88.	.38	82.5	.21	72.3	.94	94.5	.14	9.4	.33	63.6	.19	33.	.20	3.30	.14	.33	82.1
	12	281.1	.171	100.	.33	100.	1.11	100.	.46	100.	.35	100.	.105	100.	.161	100.	.73	100.	.43	100.	.195	2.95	100.	.23	100.

TABLE 6

AVERAGE DATA AND FIGURES OF TESTS ON ——— 1½-INCH STD. PIPE

TEST NUMBER	WITHOUT ELBOWS								
	1½F-1	1½F-2	1½F-3	1½F-4	1½F-5	1½F-6	1½F-7	1½F-8	1½F-9
DATE OF TEST	7-20-11	-	-		7-21-11	-	7-24-11	-	-
TEMPERATURE OF GAS AT METER °F.	88	91	89	86	87	85	78	79	76
BAROMETRIC PRESSURE, INCH. MERC.	29.46	-	-	-	29.42	-	-	-	-
MAIN PRESSURE, INCH. WATER	4.95	4.92	4.84	4.74	4.67	4.58	4.47	4.32	4.11
SPECIFIC GRAVITY OF GAS	.6698	-	-	-	.6862	-	-	-	-
DISCHARGE, CUB.FT. PER HOUR	196	302	411	518	502	705	765	683	554
" " CORR. FOR STD. COND.			390	494	532	669	746	655	534
VELOCITY THRU PIPE, FT. PER SEC.			8.06	10.18	11.40	13.83	15.07	17.40	19.40

DROP IN INCHES OF WATER AND PERCENT OF TOTAL DROP FOR EACH MANOMETER ON THE LINE	NUMBER	DISTANCE FROM MAIN	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT
	1	.7'	0	0	.01	3.8	.01	1.9	.01	.9	.02	1.63	.03	4.9	.07	3.2	.09	3.3	.10	3.6
	2	40.4'	.05	7.1	.07	16.8	.19	18.9	.21	19.3	.23	15.3	.35	19.1	.46	19.3	.53	19.1	.63	19.1
	3	61.5'	.07	25	.16	39.3	.25	23.5	.23	20.3	.26	25.9	.52	28.4	.53	24.4	.70	25.9	.91	27.
	4	63.7'	.01	3.4	.19	30.6	.23	21.1	.24	21.8	.25	25.2	.53	29.1	.63	23.	.92	34.2	.97	29.4
	5	66.9'	.03	5.1	.19	30.6	.23	21.1	.24	21.8	.24	25.9	.56	30.6	.69	29.8	.92	33.5	1.10	33.4
	6	68.6'	.07	25	.19	32.6	.24	23.1	.23	24.3	.27	24.6	.61	33.4	.73	33.6	.97	35.7	1.19	36.1
	7	69.5'	.01	25	.19	32.6	.27	26.5	.23	24.3	.24	27.3	.63	34.4	.78	37.9	1.05	37.5	1.24	37.6
	8	73.0'	.22	78.5	.33	71.7	.49	68.5	.61	96.	.52	42.6	.35	48.	1.06	47.8	1.37	49.7	1.65	49.6
	9	78.7'	.19	54.	.33	76.	.49	68.5	.65	55.6	.70	56.3	.99	83.5	1.23	56.4	1.62	59.6	1.97	59.7
	10	119.7'	.36	85.3	.50	87.	.56	75.7	.93	75.3	1.01	72.5	1.34	97.3	1.89	72.1	1.98	70.4	2.24	68.
	11	160.	.24	86.5	.42	91.2	.63	95.2	.56	94.2	1.45	77.6	1.83	93.5	1.91	88.	2.32	81.5	2.82	85
	12	198.7	.25	100	.46	100	.74	100	.593	100	1.39	100	1.93	100	2.19	100	2.72	100	330	100

TABLE 7

AVERAGE DATA AND FIGURES OF TESTS ON ——— 1½-INCH STD. PIPE

TEST NUMBER	WITH ELBOWS								
	1½E-1	1½E-2	1½E-3	1½E-4	1½E-5	1½E-6	1½E-7	1½E-8	1½E-9
DATE OF TEST	7-26-11	-	-	-	-	-	-	-	-
TEMPERATURE OF GAS AT METER, °F.	82	83	82	85	84	85	85	85	80
BAROMETRIC PRESSURE, INCH. MERC.	29.6	-	-	-	-	-	-	-	-
MAIN PRESSURE, INCH. WATER	4.79	4.96	4.30	4.79	4.73	4.68	4.39	4.53	4.41
SPECIFIC GRAVITY OF GAS	.6807	-	-	-	-	-	-	-	-
DISCHARGE, CUB.FT. PER HOUR	196	306	408	500	631	720	817	698	1000
CORR. FOR STD. CONDT.			380	476	601	683	776	840	955
VELOCITY THRU PIPE, FT. PER SEC.			8.03	9.83	12.40	14.20	16.10	17.70	19.65

DROP IN INCHES OF WATER AND PERCENT OF TOTAL DROP FOR EACH MANOMETER ON THE LINE	NUMBER	DISTANCE FROM MAIN	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT
	1	7'	.01	3.8	.01	2.5	.02	2.6	.04	4.2	.01	4.5	.06	4.2	.10	4.3	.14	4.5	.15	4.2
	2	40.4'	.09	15.8	.06	15.	.15	19.7	.16	16.5	.19	13.6	.26	17.8	.44	19.	.55	18.9	.66	18.6
	3	61.5'	0	0	.09	10.	.17	22.4	.21	21.9	.25	22.4	.45	31.6	.79	29.7	.93	29.8	.94	26.7
	4	63.7'	.05	26.3	.01	2.5	.18	23.7	.25	26.1	.27	23.7	.43	30.1	.69	26.8	.79	25.4	.97	27.5
	5	66.9'	.05	26.3	.01	2.5	.18	23.7	.25	26.1	.40	35.6	.50	34.8	.79	29.5	.91	26.2	1.10	30.9
	6	68.6'	.05	31.6	.01	2.5	.18	23.7	.23	23.9	.43	37.6	.58	40.3	.97	37.	1.19	32.9	1.18	33.1
	7	69.5'	.04	21.1	.01	2.5	.18	23.	.23	24.	.45	38.6	.60	41.3	.98	34.	1.24	34.	1.22	34.2
	8	73.0'	.11	58.	.20	50.	.37	48.7	.44	51.8	.65	41.7	.91	47.6	1.10	41.9	1.33	45.5	1.66	46.
	9	78.7'	.19	100.	.29	72.5	.45	59.2	.62	58.2	.84	53.9	1.05	55.	1.38	52.7	1.51	51.7	1.99	55.6
	10	119.7'	.18	94.7	.30	75.	.52	68.5	.68	77.	1.04	66.8	1.35	70.9	1.56	78.1	2.03	70.	2.67	74.8
	11	160'	.19	100.	.40	100.	.70	92.1	.84	95.5	1.40	89.5	1.70	89.	2.03	98.5	2.59	89.4	3.11	87.3
	12	198.7'	.19	100.	.40	100.	.76	100.	.88	100.	1.56	100.	1.91	100.	2.30	100.	2.90	100.	3.56	100.

TABLE 8

AVERAGE DATA AND FIGURES OF TESTS ON ——— 2-INCH STD. PIPE

TEST NUMBER	WITHOUT ELBOWS										
	2F-1	2F-2	2F-3	2F-4	2F-5	2F-6	2F-7	2F-8	2F-9	2F-10	2F-11	2F-12
DATE OF TEST	8-2-11	-	-	8-3-11	-	-	8-4-11	-	-	-	-	8-5-11
TEMPERATURE OF GAS AT METER, °F.	80	79	76	85	84	85	90	90	87	90	89	88
BAROMETRIC PRESSURE, INCH. MERC.	29.46	-	-	29.33	-	-	29.45	-	-	-	-	29.56
MAIN PRESSURE, INCH. WATER	4.96	4.93	4.83	4.84	4.76	4.69	4.61	4.52	4.30	4.22	4.09	3.96
SPECIFIC GRAVITY OF GAS												
DISCHARGE, CUB.FT. PER HOUR	200	300	400	487	588	706	797	889	1029	1180	1330	1310
" " CORR. FOR STD. CONDT.						674	760	823	998	1026	1140	1260
VELOCITY THRU PIPE, FT. PER SEC.						8.61	9.5	10.6	12.27	13.	14.55	15.4

DROP IN INCHES OF WATER AND PERCENT OF TOTAL DROP FOR EACH MANOMETER ON THE LINE	NUMBER	DISTANCE FROM MAIN	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT
	1	.78'	0	0	.01	4.55	.01	3.3	.02	6.5	.01	1.6	.04	4.9	.05	4.3	.07	3.4	.08	3.6	.12	4.2
	2	41.8'	.07	36.9	.08	36.3	.09	29.4	.10	32.7	.11	29.5	.19	25.6	.23	19.3	.29	19.2	.35	15.8	.50	17.5
	3	60.5'	.09	52.5	.09	17.6	.01	4.55	.06	19.5	.10	29.1	.31	39.5	.78	33.3	.35	23.1	.80	35.9	.89	31.1
	4	66.6'	.05	26.3	.09	17.6	.03	9.7	.19	61.3	.15	42.8	.22	28.5	.33	24.9	.52	34.3	.84	37.5	.93	32.5
	5	69.6'	.02	10.1	.04	7.8	.03	9.7	.10	32.6	.12	34.2	.15	19.2	.23	17.3	.33	21.8	.54	24.1	.64	22.4
	6	71.8'	.04	22.2	.06	23.1	.04	12.9	.10	24.5	.16	45.2	.25	32.2	.33	24.9	.37	23.6	.45	20.	.56	19.6
	7	72.6	.03	21.2	.06	23.1	.09	29.1	.10	24.5	.10	28.5	.26	33.1	.34	25.5	.39	23.9	.39	17.3	.53	18.5
	8	78.3	.19	100.	.23	100.	.29	93.5	.39	95.	.35	98.	.78	98.7	.93	69.2	.59	36.9	.89	39.6	.99	34.7
	9	82.4	.25	131.	.23	100.	.29	96.9	.35	96.	.34	96.	.84	94.	.97	69.7	.97	60.5	1.04	71.7	1.18	41.4
	10	126.1	.15	100.	.26	113.	.29	100.	.37	103.	.30	115.	.68	100.	.79	90.	.93	79.8	1.06	81.5	1.19	84.6
	11	164.8	.23	133.	.27	117.	.30	100.	.39	109.	.33	105.	.44	100.	.88	98.	1.08	95.	1.30	93.	1.39	96.
	12	186.	.13	100.	.23	100.	.31	100.	.36	100.	.31	100.	.44	100.	.91	100.	1.14	100.	1.40	100.	1.45	100.

TABLE 9

AVERAGE DATA AND FIGURES OF TESTS ON ——— 2-INCH STD. PIPE.

TEST NUMBER	WITHOUT ELBOWS						
	3F-21	3F-22	3F-23	3F-24	3F-25	3F-26	3F-27
DATE OF TEST							
TEMPERATURE OF GAS AT METER, °F.	74	74	74	47	47	47	47
BAROMETRIC PRESSURE, INCH. MERC.	28.98		-	29.38	-	-	
MAIN PRESSURE, INCH. WATER	3.15	3.43	3.76	2.78	3.19		
SPECIFIC GRAVITY OF GAS	6690	-	-	-	-	-	
DISCHARGE, CUB.FT. PER HOUR	2382	2475	2620	2662			
" " CORR. FOR STD. CONDT.							
VELOCITY THRU PIPE, FT. PER SEC.							

DROP IN INCHES OF WATER AND PERCENT OF TOTAL DROP FOR EACH MANOMETER ON THE LINE	NUMBER	DISTANCE FROM MAIN	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT	INCH.	PER CENT
	1	1.5'	.07	3.6	.07	3.3	0	0	.15	6.	.10	3.6	.10	3.4	.11	3.5
	2	42.75'	.31	109.	.23	12.7	.33	14.	.35	10.	.29	9.8	.29	9.9	.32	10.2
	3	62.25'	.36	18.7	.60	18.3	.94	19.2	.38	15.3	.39	14.2	.46	15.	.46	14.7
	4	66.55'	.38	19.7	.64	28.6	.46	20.3	.63	21.2	.49	17.1	.53	17.7	.59	17.2
	5	67.8'	.60	25.9	.89	18.3	.97	20.9	.45	18.	.55	20.	.57	19.4	.63	20.1
	6	68.4'	.55	28.5	.45	22.1	.45	18.3	.47	15.9	.55	20	.63	21.1	.63	18.5
	7	68.9'	.42	21.8	.52	25.6	.55	24.1	.50	20.	.60	21.8	.59	20.4	.69	21.7
	8	84.4'	1.66	86.	1.73	91.	1.85	81.	1.89	74.	2.32	84.5	2.37	80.	2.56	81.5
	9	87.2'	1.70	88.	1.77	93.	1.93	84.5	1.91	72.	2.35	85.5	2.37	80.	2.59	83.
	10	129.6'	1.66	86.	1.79	94.	2.00	88.	2.16	82.	2.50	91.	2.57	87.5	2.86	91.
	11	168.0'	1.73	89.5	1.81	95.	2.02	89.	2.32	88.	2.63	97.	2.64	91.5	2.90	92.5
	12	210.0'	1.93	100.	2.15	100	2.26	100	2.64	100	2.75	100	2.84	100	3.13	100

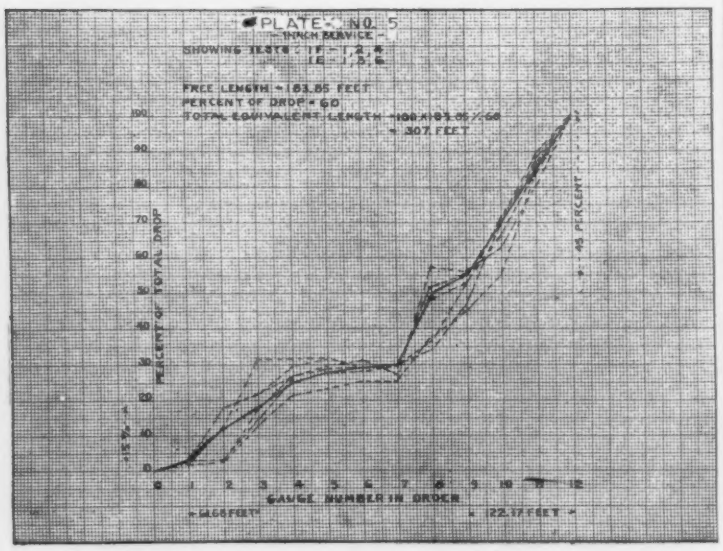


PLATE NO. 5
INCH SERVICE
FREE LENGTH = 183.85 FEET
PERCENT OF DROP = 60
= 307 FEET
PERCENT OF TOTAL DROP
GAUGE NUMBER IN ORDER

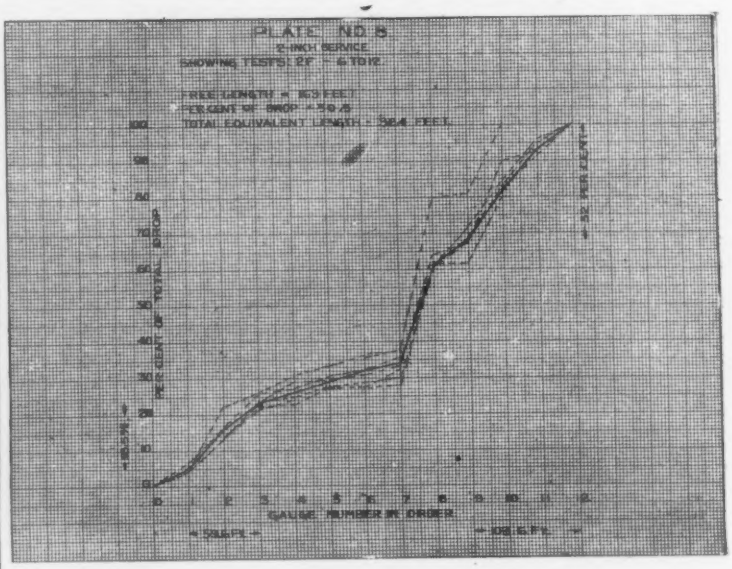


PLATE NO. 6
2-INCH SERVICE
PERCENT OF TOTAL DROP
GAUGE NUMBER IN ORDER

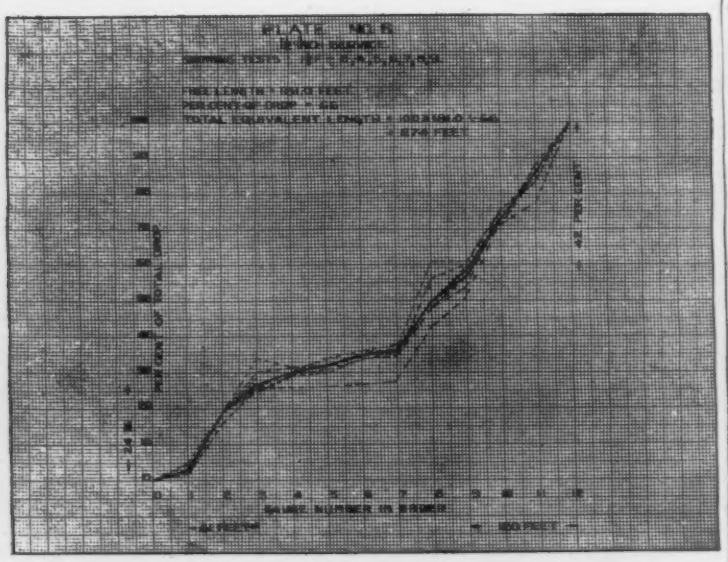


PLATE NO. 8
PERCENT OF TOTAL DROP
GAUGE NUMBER IN ORDER

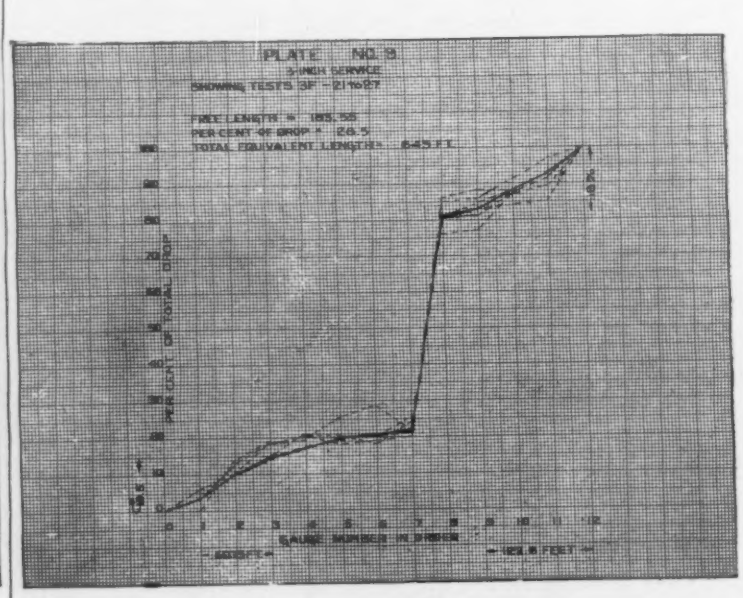


PLATE NO. 9
3-INCH SERVICE
PERCENT OF TOTAL DROP
GAUGE NUMBER IN ORDER

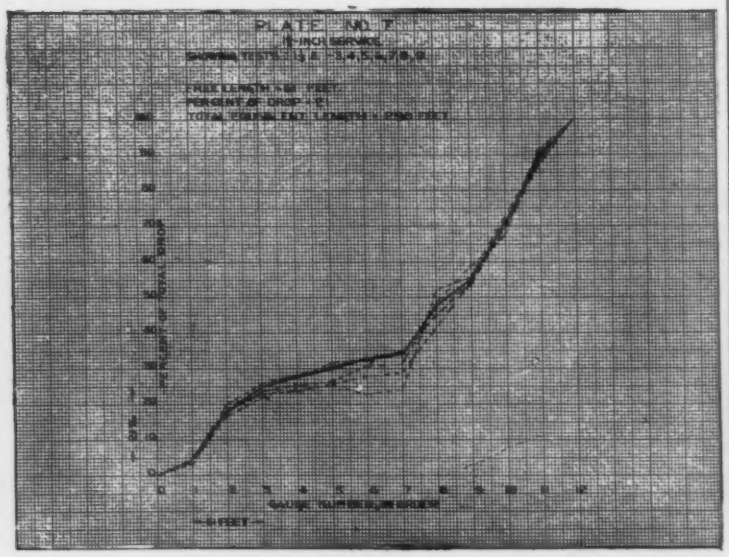


PLATE NO. 7
PERCENT OF TOTAL DROP
GAUGE NUMBER IN ORDER

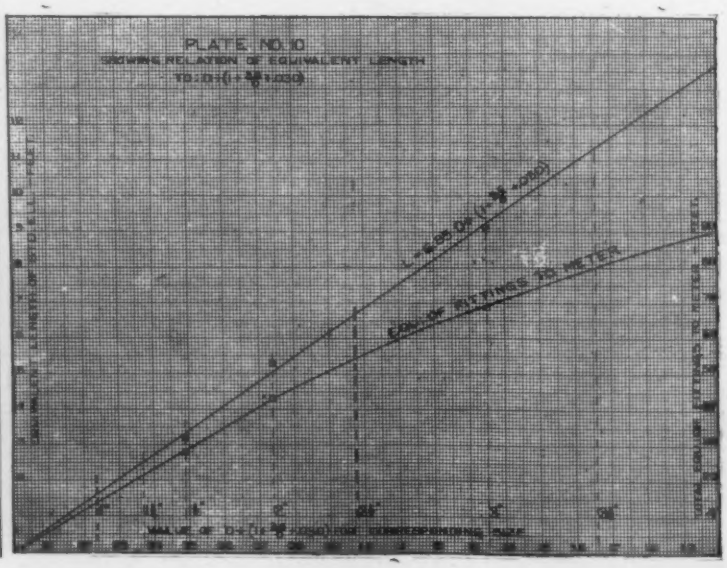


PLATE NO. 10
SHOWING RELATION OF EQUIVALENT LENGTH
TO 10.03(1+ 36/D)D
L = 10.03 D (1+ 36/D)
D = 10 RATIO TO METER
VALUE OF 10.03(1+ 36/D)D FOR CORRESPONDING PIPE

the diagrams were the first object of this work, which was followed in order to determine the proper formulæ to be used as a basis for the graphical solution of the flow of gas in pipes.

(20.) ALLOWANCE FOR UNKNOWN FACTORS.

As we have exhausted all the variables which could be given concrete form, or could be attached to some known factor of the flow, we have still at hand a number of unknown quantities, depending upon material or local conditions; as, for instance, the roughness of the walls, or possible obstructions inside the pipe, and the necessary number of fittings in a given length, which may considerably change the quantity of the flow. It was, therefore, considered best, in computing the charts, to reduce the numerical value of the coefficient given by the average line of Diagram No. 3, in order to take in the necessary fittings and to allow a reasonable amount for possible line obstructions. For high pressure lines the lowest value of C was shown as 1970, or 64.3, when the length is figured in miles. For low pressure 1,910 had to be used for the coefficient to include most of the experimental points on Plate No. 3. The equations:

$$Q = 64.3 \sqrt{\frac{PAD^5}{WL\left(1+\frac{3.6}{D}+.03D\right)}} \quad \ldots\ldots\ldots (28)$$

for high pressure, and

$$Q = 1910 \sqrt{\frac{HD^5}{WL\left(1+\frac{3.6}{D}+.03^D\right)}} \ldots\ldots\ldots (29)$$

for low pressure, are given on the respective charts where the method of their practical solution is fully described and illustrated.

(21.) SOLUTION FROM CHARTS COMPARED WITH OTHER FORMULAE.

A full comparison between the computed charts and the other formulæ for the various sizes of pipes is shown on Plate 4, which was plotted from the figure to Table No. 2. The curved line, marked A, shows for each nominal size of pipe the number of cubic feet as given by Pole's formula against 100 cubic feet given by the low pressure chart. The curve marked B shows the same for Unwin's formula against the high pressure chart. It should be noticed that Dr. Pole figured his formula to give the amount of free gas at 32° F.; Prof. Unwin took the temperature of 50° F., and the charts were computed to give the amount of free gas at 60° F., which is considered the standard for comparison at present. The curves on Plate 4 were plotted, however, according to the original figures of the authors, and the correction for 60° F. would make additional 5 per cent. for Pole's formula, and about 1 per cent. for Unwin's. By reference to Plate 4, or Table 2, a solution from the low pressure chart can be easily transferred to yield the corresponding amount given by Pole's formula, and a solution from the high pressure chart will do the same for Unwin's formula, thus affecting the solution of these formulæ without actually solving the same.

(22.) LENGTH OF STRAIGHT PIPE EQUIVALENT TO RIGHT ANGLE BEND.

In the tests on street mains, referred to in the previous chapters, there was an average of 2 right angle bends to the mile of pipe. It may be necessary sometimes to allow a drop of pressure for an excessive number of bends in the line, and for that purpose it is desirable to have an expression showing the additional length of straight pipe which would cause an equivalent drop of pressure under the given conditions. The effect of a sharp turn in the line is, virtually, to stop the flow, absorbing some of its kinetic or velocity energy. This causes a corresponding amount of pressure to be changed into the renewed velocity of the flow. The velocity drop being a function of the flow only (as is clearly seen from the fundamental equation $H = \frac{V^2}{2g}$) is wholly independent of the size of the pipe. Therefore, if the velocity is the same, the drop of pressure resulting from the sharp turn in the line will be constant for all sizes of pipes. As the length of straight pipe to cause a constant drop for the same velocity varies with the diameter of the pipe, the length equivalent in effect to a bend in the line will also vary in the same proportion. To determine this relation we have from equation (10)—for p, v and j constant:

$$p = \frac{4fl}{d} \cdot \frac{v^2}{2g} j.$$

Therefore

$$f\frac{l}{d} = k \text{ or } l = k\frac{d}{f} \ldots\ldots\ldots\ldots (30)$$

Substitute in equation 30 the value of f from equation 24 and, taking the diameter in inches, we have,

$$j = \frac{K_1 D}{\left(1+\frac{3.6}{D}+.03D\right)} \ldots\ldots\ldots (31)$$

Where l is the equivalent length in feet, D the diameter of the pipe in inches, and K_1 is a constant to be determined by experiment. It was shown in the latter part of this work that K has the value of 6.85 for a standard elbow. This value was used in equation (31) for figuring the equivalent lengths of standard elbows given in Table 3.

(23.) EQUATION OF PIPES, DIAMETERS AND LENGTHS.

It is often required to compare the capacity of various sizes of pipes for the delivery of gas under even conditions. Sometimes it is required to figure the flow of gas through a certain length of pipe having sections of various diameters. From the equations adapted for the computation of the diagrams we see that the capacities of pipes are proportional to:

$$\sqrt{\frac{D^5}{\left(1+\frac{3.6}{D}+.03D\right)}}$$

And length through which the same capacity can be delivered for a given drop is proportional to:

$$\frac{D^5}{\left(1+\frac{3.6}{D}+.03D\right)}$$

Using this proportionality, Table 4 was computed as an auxiliary to the diagrams. This table is diagonally divided into 2 parts, the lower half showing the number of pipes of a smaller size equivalent in carrying capacity to one larger size pipe. The upper half shows the number of lengths a larger size pipe will take for one length of a smaller size to deliver the same quantity of gas with the same drop of pressure. The lower half of the Table can be used in a general way for comparison of various sizes—the use of the upper half will be illustrated in the following problem:

(24.) SOLUTION OF PROBLEM.

Required the capacity for a given drop of pressure, through a continuous line miles long, having 5 miles of 24-inch, 3 of 16-inch, and 2 of 12-inch pipe. Using the 24-inch pipe as a basis, and consulting Table No. 2, we determine the equivalent length thus:

1 mile of 12-inch is equivalent to 28.4 miles of 24-inch.
1 mile of 16-inch is equivalent to 6.93 miles of 24-inch.
1 mile of 24 inch is equivalent to 1 mile of 24-inch.

2 × 28.4	= 56.80
3 × 6.93	= 20.79
5 × 1.	= 5.00
Total...	82.59 miles.

Which is the total equivalent length to be used when solving the problem on the diagram.

Suppose the initial pressure in this case to be allowed 5 poun gauge, the final to be holder pressure, or about ½ pound; the densi to be 0.65, then: p = 5 — ½ = 4.5.

D = 24 inches.
W = 0.65 inches.
A = 3.75 (the chart is ma rked for gauge pressure).
L = 82.59.

To find Q on the high pressure chart, start with 4.45 for P vertically to 24 inches, D, horizontally to 0.65, W, vertically to 3.75, A, horizontally to 82.59, L. Read Q at this point, viz., 165,000 cubic feet per hour.

PART II.

(25.) EXPERIMENTS ON SERVICE PIPES.

The tests on smaller sizes, referred to in previous chapters, were performed by the engineering department of the Peoples Gas Light and Coke Company, with the object of determining the quantity of gas which can be delivered through the regular sizes of service pipes at a given drop of pressure from gas main to meter.

In preparing the layout for the tests the main consideration was to have the arrangement similar to service pipe in actual use, with all the necessary fittings attached to the line. The connections of the piping are shown in detail on Fig. 1. In each case the pipe of a given size was tapped into a piece of 22-inch pipe, representing the gas main, into which illuminating gas was supplied at a pressure of about 6 inches, water. About 60 feet of straight pipe was laid between the main and the gas meter, and about 120 feet was added on the other side of the meter to increase the data of the test for future comparison. Proportional (5 to 1) water manometers, 13 in number, were placed on the line, about 40 feet of straight pipe apart, and at close intervals between the various fittings from main to burner. The rate of flow was measured by dipping meters (20-light and 100-light capacities) and readings of the manometers were taken simultaneously by a number of observers.

(26.) TESTS AND OBSERVATIONS.

Following are the tests performed in order and data represented to present date:

1. Test 1-F, including 6 sets of readings on various discharges through a 1-inch pipe with connections and fittings, as shown on Fig. 1.
2. Test 1-E, including 5 similar sets of readings on the same 1-inch service, having put 5 additional elbows in the line after the meter.
3. Test 1¼-F, including 14 sets of readings on the flow through a 1¼-inch service pipe of the same arrangements as shown in the Figure.
4. Test 1¼-F, including 7 similar sets on the same 1¼-inch service pipe, with additional elbows in the line after the meter.
5. Test 1½-F, including 9 sets of readings on a 1½-inch service pipe, arranged in the same manner.
6. Test 1½-E, including 9 sets of readings on the same 1½-inch service pipe, with additional elbows in the line after the meter.
7. Test 2-F, including 12 sets of readings on a 2-inch service pipe.
8. Test 3-F, including 7 sets of readings on the flow through a 3-inch service pipe arranged as shown on the Figure.

(27.) CONDITIONS.

Some of the observations were made at an abnormal outside temperature, causing the pressure readings to fluctuate very irregularly for the same discharge. In other observations the flow of gas was so small that the drop between 2 consecutive gauges was less than

the possible error in the reading of a gauge. The irregularity of the flow in the line, caused by a movement of the tangent in the dipping meter, was probably a source for some error in the readings of the manometers. It was evident, as soon as the data was tabulated, that many of the observations are inconsistent with the conditions of the test; when, for instance, a gauge further in the line would show a higher pressure than another gauge ahead of it.

(28.) ANALYSIS OF TEST DATA.

Following is the method of analysis which was employed to determine the probability of individual observations, and to eliminate doubtful data from the figures of the tests:

Referring to Tables 5 to 9, the general data of each test is followed by a Table showing the drop of pressure in inches of water, and the corresponding per cent. of the total drop for each manometer on the line. The figures of the drop in pressure are marked, in order 1 to 12, corresponding to the 12 gauges on the line, zero being marked for the main gauge on the line. The drop from the main to gauge 12 is termed the total or 100 per cent. drop for the given discharge, accordingly, the drop from the main shown by each gauge constitutes a per cent. of this total. This per cent. is marked along the figures of the corresponding drop on the same Table.

From the data of these Tables (5 to 9) a corresponding number of curves (plates 5 to 9), were plotted with even spaces for the manometers in order, as abscissae, and the corresponding per cent. of total drop in pressure as ordinates. In analyzing these curves, advantage was taken of the fact that the drop of pressure between gauges 1 and 3 in every test, and also between 9 and 12 in the tests marked F, was produced by a straight length of pipe. Hence the per cent. of total drop per length of pipe would have to be the same for the distance between the gauges 1 to 3 and 9 to 12 for every separate observation. This was taken as a test of probability for each observation and, therefore, those observations which declined considerably from the general slope when the points were connected on the plate, were rejected as improbable, and not figured in the results.

(29.) THE EQUIVALENT LENGTH.

Following the general slope of the curves for each size, a heavy line was drawn as the average, and from this line the per cent. of drop from one gauge to another was scaled off and tabulated (see Table No. 10). Then, having the per cent. of the total drop produced by the known length of straight pipe (marked free length on the diagram) the equivalent length of straight pipe in proportion to the total drop was computed for each size as noted on the respective plate.

In the same manner the equivalent lengths of the various fittings between gauges were computed from the average per cent. of drop through those fittings as shown on Table 10.

In the case of service piping, where the drop through the fittings constitutes a considerable per cent. of the total drop, it is always necessary to take into consideration the equivalent length of the fittings when figuring the flow through a given size. The additional length of straight pipe to be figured for the standard fittings used by the Peoples Gas Light and Coke Company, is given in Table 11. for nominal sizes of pipes from 1 to 4 inches diameter. In this Table the figures for sizes 1¼, 2 and 3 inches are the averages from tests as given in Table 10. The figures for the other sizes were computed by manipulation of the same average as shown on Table No. 10.

Referring to the equivalent length of a standard elbow, we see on Plate 10, where the sizes were spaced according to the value of

$$\frac{D}{\left(1 + \frac{3.6}{D} + .03D\right)}$$

that the experimental points follow closely the straight line having a slope of 6.85 to the base of the curves. According to this (equation 31) computed in the first part of the work takes the form of

$$l = \frac{6.85D}{\left(1 + \frac{3.6}{D} + .03D\right)} \quad \ldots\ldots\ldots (32)$$

where l is the longth of straight pipe in feet equivalent in effect to one standard elbow in the line, and D is the diameter of the pipe in inches.

(To be Continued.)

Special English Correspondence.

COMMUNICATED BY NORTON H. HUMPHRYS.

LONDON, ENGLAND, April 10, 1912.

The Coal Famine.

Throughout the month of March we have experienced a coal famine, of a nature that does not come within the memory of the oldest inhabitant, and that inaugurates a new era in connection with industrial problems. A complete holding up of the coal or any other industry throughout the country, for a matter of about 6 weeks, is an entirely new experience that commends itself to the anxious consideration of all who are interested in regular supplies of coal. As mentioned last month, gas engineers have always relied upon their coal merchants. There have been occasional stoppages on account of labor troubles, it has been shrewdly observed, not unconnected with the amount of shot in the federation locker, as in 1893, and in 1873, but they have at the least been confined to particular districts. The loss in output has been met by other districts, and although coal has reached high prices, perhaps double the normal rate, it has always been obtainable. We have never before been met with the reply, "Not a ton of coal on the premises." A National Miners' Federation has now been formed, and as usual with bodies of this class, feels called upon to justify its existence. And the way in which it has effected this object does not command the sympathy of the public, nor, if one may judge by the very erratic and conflicting results of the various ballots that have been taken in connection with the strike, the unanimous support of its members. On the 29th February the Federation issued a mandate to the effect that all work was to cease, and it was carried into effect, with the exception of one or two non-federation pits, and this order was not officially revoked until last Monday, April 8th. Its withdrawal was then put through with undignified haste, because during the last fortnight work has gradually been resumed. The strike fund had been exhausted and the miners had to face either work or short commons, and wisely chose the former alternative, without waiting for orders from headquarters. Many of them had got tired of holiday making, and wished to get to work. It is rather remarkable that a large number of these gentlemen, whom the public are asked to believe do not get a living wage when in full work, have been able to have a high old time, over the last 6 weeks, in the way of seaside excursions, football matches, and all sorts of amusements, on nothing but their strike pay.

The position opens up many important public questions, political, financial and social, that could not appropriately be discussed on this page. I have endeavored to adhere to the rule that is observed in good class commercial rooms at hotels, by avoiding debatable subjects of a religious or political character, and in accordance with that practice, propose to confine attention to the immediate and prospective effect of the new conditions in relation to supply of coal. As already remarked, we have been accustomed to rely on our coal supply, and while that position will be considerably modified in the immediate future, the coal supply will still occupy an important position. The exact measures that will be adopted, in view of the fact that the Federation may, at any moment, at the bidding of a few hare brained politicians, or quarrelsome workmen, render it impossible to obtain adequate supplies on any terms, or force us to buy inferior material at panic prices, will vary according to circumstances, but will all tend to the displacement of coal in favor of other materials. It has long been known that the matter of substitutes for coal is simply a question of prices. Coal has been preferred as being cheap and reliable, not because other material cannot be used. The experiences of the last 6 months have shaken our confidence in coal, and before another winter is on us the coal requirements of the gas industry will be reduced 20 per cent.

Referring for a moment to the general aspect of the question, it may be mentioned that the nominal price of household coal has approximately been double the normal rates, while gas and steam coal have reached threefold. I say *nominal* prices, because as a rule no business has been done, with the exception of small lots in special instances. There has been no serious hardship on the well-to-do or middle class householder, who has cut his fuel consumption to the lowest possible limits and at the worst has purchased small quantities sufficient to carry on. There has been no panic, such as was hoped for and, indeed, was confidently expected. Fortunately the weather has been favorable, for which no thanks are due to those who for their own selfish purposes have placed coal in the position of a prohibitive luxury to the principal part of our population for a matter of six weeks, at a period of the year when frost and snow are not unusual visitors. With a high thermometer and the assistance of gas and petroleum, there has been no serious suffering, such as might be looked for as a consequence of shortage in respect to a household necessity, and this specially applies to the poorer classes. But a large extent of acute privation has been caused by the partial or entire stoppage of industries dependent upon a regular supply of coal and by the restricted railway service. Some have gone so far as to refuse all heavy traffic other than actual foodstuff, and the effect, as regards manufacturers of heavy machinery and such like, can be easily imagined. I hear of one town in which all building operations were stopped on account of shortage of lime, which had to be brought a matter of 20 miles, and the railway refused to carry on any terms. An astute coal merchant offered to sell 2 tons of coal to the company if they would bring through a bunch of lime. The upshot was that a representation went to headquarters that the lime was required for gas purification, and a supply came through. Not an ounce went to the gas works. This illustrates the hide-bound, red-tape system in which our railway traffic is conducted. Anything out of the ordinary rut upsets the whole Contradictory orders come from headquarters 2 or 3 times a day, and the result is all sorts of delay and confusion. In my own experience, material despatched 3 weeks ago is held up somewhere or other on the way. Under such circumstances many important industries dependent on supplies of coal or regular railway service are obliged to go on half time or to shut down entirely. The result is that millions of workers who have no immediate interest in the cause of dispute have either had to accept reduced hours or entire stoppage. One or two collieries which happened to have large stocks, perhaps 100 to 200,000 tons, have been able to clear at a profit of an equivalent number of sovereigns. And all sorts of rubbish, such as the sweepings of colliery yards and coal wharves, has been dumped on to the market under fancy names, calculated to lead the purchaser to believe that he was securing the best gas coal. Any delusion of this sort was quickly removed on receipt of the first consignment. Local papers have been watched and any announcement of shortage has resulted in the receipt of telegrams and letters offering assistance, but such help has tended more in the direction of reducing balances at the bank than of filling the gas holders.

But in very few instances, so few as to form the exception rather than the rule, has there been any important shortage or public inconvenience in connection with the supply of water, gas, or electricity. Of course, stocks are running down at an alarming rate, and a very few weeks continuance of the stoppage would mean a different tale. So far as the talk of the gas business was concerned, sufficient coal was on the ground, or the assistance of a carburetted water gas plant was available, and there was no cause for anxiety. One or two have been selling surplus coal at a profit, and others have improved the occasion by advertising the advantages of gas, and urging free use. But the usual difficulty has been that customers required no urging, being keenly alive to the fact that gas at about 2s. 6d. per 1,000 cubic feet is cheaper than coal at 40s. per ton. Many gas engineers who were quite easy under conditions of normal consumption, found themselves confronted with an increase of 10, 15 or even 20 per cent., coming on coincidentally with the notices of a stoppage of the coal supply, and probably for the first time in their lives were dismayed by an increased consumption. To meet this position reductions in the public lighting and other restrictions were called for that would not otherwise have been required. Now that daylight begins at 4 A.M., very little inconvenience is caused if the public lamps are extinguished at midnight. Occasionally handbills or advertisements soliciting a reasonable economy in the use of gas have been put out and have in all cases received sympathetic support.

For the moment things tend to a resumption of normal conditions. The railway companies have promised to make substantial improvement in the public service, but one result of the new experience is that considerable modification will be made, which we are told will be in the interest and of public convenience. But the probable direction in which the innovation will move, will be making two trains do the work of three. It has been a matter of common knowledge that competition between companies traversing the same district has been carried to such an extreme that both are losing money. In some instances the passenger traffic is conducted at a loss, the profits being earned by exorbitant rates on heavy goods. If the companies honestly wish to advance public convenience, they may certainly cut down the passenger traffic, but might well consider the present rates and arrangements for full truck traffic, consisting of loaded wagons that are simply taken off a private siding at the one end, and delivered on to another private siding at the other. Any addition to business rendered possible by lower rates would result in increase of tonnage carried. That there is some reason in the complaint about heavy goods traffic is shown by the fact that in many districts the rates are the same as before the introduction of railways, when the country was intersected by canals. Surely a freight train of 60 ten ton wagons at 20 miles an hour must be cheaper in working costs per ton carried than a 20 ton barge pulled by horses at the rate of 4 miles an hour, but the public get no benefit. In many cases, also, the time element was in favor of the barge. It is no unusualmatter for a truck of coal, carried 200 miles to be over a week on the road.

There is no reason for blinking the fact that the coal strike was simply an attack of labor interests, so far as such may be considered coincident with higher wages, was on the general public, and that a repetition of such attacks is to be expected and guarded against. The object is to exact terms at the point of the bayonet, by controlling supplies of food stuffs and other necessities of life. It was hoped that coal would afford a convenient implement. Possibly the failure in the present instance will not be regarded as final but as a preliminary attempt will be made to run down stocks above ground and to bring about an absolute coal famine, no gas, water or electric supply and no coal in the domestic cellar. So attempts may be made on the transport service, but in this instance it can be largely frustrated by road traction. During the last month large quantities of freightage have been carried up to 100 miles by road.

Fig 1

Fig 2.

Management & Commercial Methods.

THE TRANSPORTATION DEPARTMENT, ELIZABETHTOWN (N. J.) GAS LIGHT COMPANY.—The accompanying pictures illustrate the automobile outfit of the appliance division of the Elizabethtown Gas Light Company, of Elizabeth, N. J.; also, of handy storage sort in the shop of the same well managed corporation. Of course, these matters come under the supervision of Mr. F. Engel, General Superintendent of the Company, and of Mr. C. C. Denton, Manager of its appliance division. The auto equipment (shown in Figs. 1 and 2) consists of 2 "International Harvesters;" 1 auto-car, converted into a vehicle similar to the "Harvester," and 1 "Overland Roadster," all of which are in daily use. Several more cars are about to be put into service in due time, and until the entire transportation of the Company (11 horse-drawn vehicles yet remain in service) will be automatically done.

The pipe rack (shown in Fig. 3) which is solely traceable to the inventive genius of Mr. C. C. Denton, carries over 10 miles of 10-foot lengths of pipe. The rack is built on a concrete foundation, 4 feet in depth. Its dimension are: Height, 10 feet; width, 6 feet; length, 7 feet 6 inches. Its carrying capacity is:

Lengths, Feet.	Size, Inches	Sort.	Length, Feet.	Size, Inches.	Sort.
880	2	Black	10,850	⅜	Black
2,480	1½	"	11,310	¼	"
3,160	1¼	"	550	1	Galv.
5,280	1	"	890	¾	"
9,120	¾	"	1,330	½	"
5,320	½	"	2,170	⅜	"

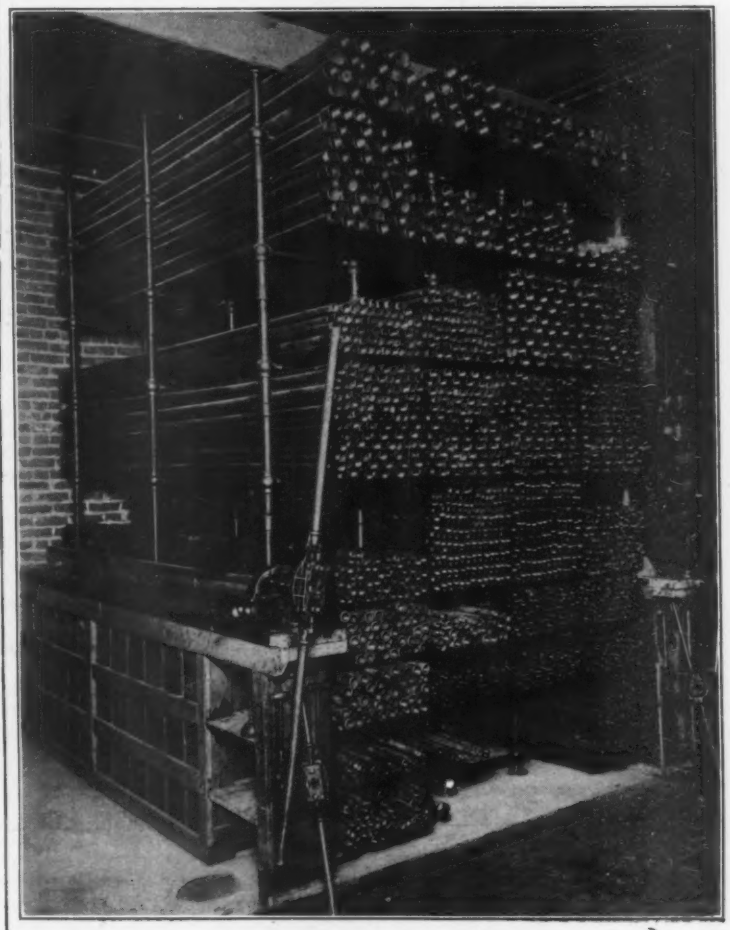


Fig. 3.

As one can see at a glance the quantity of pipe on hand, there is no excuse whatsoever in running short of any particular size, with a rack constructed on the lines originating with Mr. Denton some 3 years ago. The slight increase in cost of purchasing pipe in this way is not worthy of consideration, the scheme enabling the fitter to make stove runs without the aid of an assistant; also, in travelling the highways with a loaded truck, there is no protusion, thereby making it a safeguard for pedestrains in crossing street corners, also to vehicles which ofttimes come in contact when the long lengths are carried, making one liable for damages. Liability to accident is entirely done away with when short lengths are carried through thoroughfares.

THE BALTIMORE COMPANY AS LOANER OF CHINA.—The Consolidated Gas, Electric Light and Power Company, of Baltimore, had such frequent calls from religious, fraternal and social organizations desirous of obtaining a contribution of money through the channel of an advertising programme that 2 years ago it decided to discontinue that form of advertising altogether. Nevertheless, the Company felt that such gatherings offered an opportunity for profitable publicity and afforded an avenue for the application of its policy, which is to cooperate in a more or less intimate way with all of the activities of the community. As a means to this end the plan of having a set of china for the use of these assemblings was decided upon. The plan in itself was not novel, for it has been successfully utilized by large department stores; but the fact that the Gas Company was "lending dishes to church fairs" was in itself of sufficient novelty to attract attention that warranted the expenditure.

The dishes, which were made to order, consist of a white hotel china, decorated with the Company's trade mark, which is a crest combining the words, "Cook with Gas." This is not an offensive advertisement and, in fact, rather lends attractiveness to the china. The order was for—

200 flat plates, 7 inches.
200 bread plates, 5 inches.
200 individual butters, 3 inches.
200 medium size cups.
200 medium size saucers.
400 vegetable dishes, 3 inches.
60 bakers, 8 inches.
36 bakers, 6 inches.
200 fruit saucers, 5 inches.
200 individual meat dishes, 5 ins.
36 meat dishes, 12 inches.
60 covered sugar bowls.
60 cream pitchers.

China of Baltimore Gas Company in use at First Baptist Church, Baltimore.

During one month this winter, application was made for the use of the china by various organizations on every night. Some nights, two or more organizations used parts of the set. Those desiring the china, having made application to the Commercial Department, sign a contract, specifying the number of each dish desired, the cost of each article, the time and place the china is to be delivered and called for. The china, carefully crated, is delivered in one of the Company's wagons, the key to the crates being given to a responsible party. The wagon calls for the china and returns it to the Company's building. All dishes broken or missing are billed at cost price to the party signing the contract. This was found necessary to insure that care will be taken of the china, and protects it both from breakage and souvenir hunters.

The loan of the china is of of praetical help to those organizations arranging suppers for charitable purposes. It makes unnecessary the renting of china from a caterer, the cost of which would be far greater than the returns from an advertisement, should the Company insert one in the programme. The returns to the Company are greater and the expense very much less. A set of such china can be bought at an outlay of a few hundred dollars, while the average expenditure for programme advertising by a Public Service Company would amount to several thousand dollars annually. The Baltimore Company has also made use of japanese paper napkins, the "Cook with Gas" crest being stamped in the corner. These are very inexpensive.

Complete set of china which the Baltimore Gas Company lends to religious, fraternal and social organizations.

Items of Interest
FROM VARIOUS LOCALITIES.

THE authorities of Des Moines, Ia., report that the expenses allowed upon their conduction of the action which resulted in sustaining an order of the City Council that 90 cents per 1,000 cubic feet was a just rate for gas in Des Moines, amounted to $21,826.78. Of this sum "Doctor" Marks was paid $7,601.89—he could not in justice to himself add 11 cents to that amount. It would have saved the city accountants vastly more than that sum had the "Doctor" been able to see his way clear to having bought 11 cents' worth of—postage stamps, mayhap!

THE Annville-Palmyra (Pa.) Gas Company is extending its distribution system to Derry Church. We believe that the Hershey district, in which the Hershey chocolate factory is operated, is already hooked up.

THIS seems like swallowing the camel, but choking over the gnat, but the facts are these: A great many of the residents of Cedarhurst, Long Island, are anxious to secure gas, and have petitioned the Village Trustees to permit the Queens Borough Gas and Electric Company to put in the necessary services—the mains have been fairly well under the highways for some time. The Village Board declares that the Gas Company must deposit $2.50 as a surety that the street surface shall be put in proper repair after each service is laid—that is, $2.50 for each service—the Gas Company declares that this deposit is up to the consumer, and the consumer avers that, as he cannot get gas until all the bills incidental to the laying of the service pipe are settled, the surety fee is up to the others; certainly, that it is "away by" him. It is remarked, however, by the locals, that people whose credit is in fair standing find little difficulty in having the supply laid on.

THE Peoples Gas Company, of Ponca City, Okla., has been incorporated at Ponca City, with a capitalization of $100,000, by Messrs. E. W. Marland, B. L. Hobbs and L. N. Wents, all of Ponca City.

MR. WM. CROKER, of Atlantic City, N. J., has been appointed Superintendent of the Wildwood (N. J.) Gas Company.

THE authorities of Lakeland, Fla., have granted to Mr. W. R. Peters and associates, of Minneapolis, Minn., the right to construct and operate a gas works in Lakewood. It is estimated that it will cost $50,000 to build the plant and pipe the territory, and it is declared that the franchise shall be forfeited if gas is not laid on within a year. There is little doubt that no forfeiture will ensue, since the exploiters have put the proposed system, during the construction period thereof, under the careful charge of Mr. J. F. Seamon.

"B. S. B.," writing from Richmond, Va., under date of the 20th inst., says: "I failed to note anything in the JOURNAL respecting the decision of Judge H. C. Hervey in respect of the case of the city of Wheeling, Va., *vs.* the West Virginia Natural Gas Company. By

this decree is made permanent the injunction prayed for by the city to restrain the Company from selling natural gas as an illuminant. The decree also avers that the city is entitled to recover damages for violation of contract by the Company for gas already so sold, and while this quantity may be difficult to determine, it may (likely will) reach into thousands of dollars. The decree in preamble recites the taking of depositions in the case and of the exhibits filed, and then cites that after careful consideration he is of the opinion that the ordinance passed April 17, 1885, by Council and accepted by the Company created a contract between the two and made it obligatory on the part of the Company to refrain from selling gas for other than heating purposes or in competition with the city unless by consent of the plaintiff. Also, that it was the duty of the Company to see that the gas conducted through its pipes was not used for illuminating purposes so as to be in competition with the city. Also, that the defendant had been and was allowing the gas to be used for this purpose, according to the evidence, therefore the city was entitled to damages and to the injunction prayed for. Then follows the order of the court restraining its officers and employees from selling gas for illuminating purposes in competition with the city, and it is further ordered that the matter be referred to Court Commissioner F. A. McMahon to ascertain and report on the amount of damage the city has sustained by reason of this violation of contract and report the finding to the court."

THE new holder, to ensure the supply of gas to the South Richmond district of Richmond, Va., will be located on a plot east of the Seaboard Air Line property, to the north side of Dock street.

WE understand that Mr. Henry Sanderson, of the firm of Chas. D. Barney & Co., of New York city, has purchased a controlling interest in the Cohoes (N. Y.) Gas Light Company.

MR. WILLIAM H. HART, of New York, has been appointed General Manager of the Westbrook (Mass.) Gas Company, thus relieving Mr. Clarence P. Sawyer of the management and permitting him to fill with better satisfaction all round to the engineering end of the Company's trafficking.

GOVERNOR POTHIER has signed the Rhode Island legislative sanction to the petition of the Providence (R. I.) Gas Company permitting it to increase its capital stock to $10,000,000.

MR. W. G. AINSLEY, since 1910, with the Peoples Gas Light Company, of Davenport, Ia., has been appointed Superintendent of Construction by the Keokuk (Ia.) Light and Power Company.

THE Hutchinson Gas Company, to take over the business of the existing Hutchinson (Kas.) Gas and Fuel Company, has been chartered. It is capitalized in $600,000, and its incorporators are: Messrs. Herbert Smith, E. E. Blockley, W. R. Glass, C. H. Brooks and Samuel Mountain. It is likely that Mr. Mountain will continue as Manager.

MR. ORRY R. EVANS, as Attorney for Mr. L. Burkhard, of East Syracuse, N. Y., has been granted a franchise by the officials of that settlement to manufacture and distribute gas to the residents. The maximum rates allowed are: For public use, $1.00 per 1,000 cubic feet; on other account, $1.50 per 1,000. It is said that construction work will be commenced forthwith; but we shall see.

AT the special election by the voters of Nashville, Tenn., the franchise for the new Nashville Gas and Heating Company, recommended by the City Council and sanctioned by the Mayor, was adopted by a decidedly affirmative ballot. The total vote cast was 5,045, those in favor numbering 3,201 leaving 1,844 in the negative. The vote, as compared with the average ballot that sees the end of an active political canvas, was light, but nevertheless its magnitude exceeded any estimate made in advance respecting the total. This is most satisfactory to all concerned, for in view of the decisive majority recorded there can be no doubt that the will of the voters has been plainly expressed respecting even quasi-public ownership in Nashville public utilities. Under this result the Nashville Gas and Heating Company will have paid (last Friday) into the City Treasury the sum of $100,000 upon which transfer the contract will be complete and binding. It is further covenanted that the succeeding Company within 30 days, shall pay for and take up all the stock in the old Nashville Gas Company at the price agreed upon, and that within the next 5 years the operating Company shall expend not less than $500,000 in betterments and extensions, etc. The new operating agreement also provides that the maximum selling rate for gas in Nashville shall not exceed $1 per 1,000 cubic feet, until 1922, when a board of arbitration shall decide the legal or equitable rate for the ensuing 10 years, and so on during the life of the franchise, as to each 10-year period thereof—the present franchise life is to run for 40 years. One feature of the agreement is rather binding upon the purchasers, in that the city may, at the end of 30 years, exercise the right to buy the properties at a price to be agreed upon through ordinary arbitration proceedings, process of which is outlined in the franchise.

MRS. LOUISE CRAIG, Lecturer and Demonstrator in Household Science, Indiana University (Bloomington), early this month delivered an address on "Household Science" which it would be well worth while to put before the users of gas in many household, where gas is obtainable. The lecture, of course, was devoted in general to the value of modern household science, the scope of which subject is naturally broad, wide and deep, thus causing mention of many co-related matters; but, in respect of kitchen fuels, this clever woman, leaves little space for choice when the matter of choice of such fuel is reached. The chief paragraph in respect of "Gas in the Kitchen" is here reproduced: "No one is any longer using the old-fashioned coal range who can get gas for cooking purposes, for the reason that with gas the cook controls the fire to a very fine point and can get just the amount of heat necessary to do the work and as soon as she has finished, turn it off, and each day we realize what the wise man who discovered it has done for the ease and comfort of the home makers of the civilized world. Its introduction into the need of society makes it a transforming power in the kitchen as well as in our nation."

AN interesting event in the month's history of Marion, Ind., was a visit to the plant of the Central Indiana Gas Company, by the members of the Class in Chemistry, of the Marion High School, under the tuition of Mr. H. M. Ibison. The visit was made at the invitation of the Gas Company, and the visitors (they numbered 21, of whom 6 were lassies fair to see) were received by Manager Clifford and Superintendent Bartow. The party were taken leisurely through the plant where piece of apparatus and its function were quite plainly described by the guides. When the tour was at an end the boys in the party ascended the "spiral staircase" leading to the top of the fully inflated gasholder—height of 115 feet—which altitude enabled the youngsters to enjoy a perfect birdseye view of their home city and its natural environments, and they did enjoy it, although, as expressed by Master Ira Bowman, it was a pity the girls could not "take in the glorious sight." As a sequel to the inspection, Mr. Clifford offered a prize of $5 in gold to the boy or girl who would, within 15 days, write the best essay on what he or she had seen during the visit.

"ONE of the most interesting recent events in the history of the 'Peoples Settlement' was a dinner given by the Wilmington (Del.) Women's Domestic Science Class. This Class has been conducted at the expense of the Wilmington Gas Company, and the results accomplished in the twelvemonth were nicely demonstrated in the well cooked food, that was shared by 30 pupils and officials of the 'Settlement,' and of the Gas Company. Mr. T. A. Hilles presided at the dinner, and at his invitation Manager H. S. Schutt (and Manager he is in every good and useful sense) responded to a toast which had for its pith the patience of the pupils who had succeeded so well in their studies. In fact, as Manager Schutt put it, none of the works' men had more than a passing estimate of the value of the results achieved by the 'Settlement' workers. Manager Schutt also had much praise for the painstaking, connected, satisfactory teaching by the Company's Demonstrator, Mrs. Herman. Mr. Herman also detailed the routine, and spoke in commendatory terms of the eagerness shown in practically following up the courses by the pupils. Mrs. Lynch, of the Women's Improvement Club, thanked Mrs. Herman, Manager Schutt and his resourceful aides, and the Gas Company, as well, for their liberality, which had not even the taint of stinginess about it—this sentiment was cheered to the echo. Mr. Irving Warner also made a felicitous speech, after which the guests were shown to and through the building, and many expressions of surprise were vented over the capacity, completeness, and actual beauty of the establishment in general. The guests of the evening were: H. S. Schutt, General Manager; R. H. Lawler, Superintendent; W. Morris, Business Manager; D. C. Plank, Chief Clerk; President of Settlement, T. A. Hilles; First Vice-President, Miss M. S. Malone; Head Worker, S. W. Pyle; Kindergarter, Miss Jane Gadd.—V. M. V."

THE property formerly owned by the American Chrome Company, on Grove street, Arlington, Mass., has been acquired by the Arlington Gas Company, and thereon the Company proposes to erect a modern plant that will be up to furnishing gas to the fast growing sections of Arlington, Belmont and Winchester. As a starting mark of its intention the Company, as our readers are likely aware, is now constructing a holder that will retain 500,000 cubic feet.

MR. JAMES H. SLADE, son of Mr. Richmond E. Slade of the New Orleans (La.) Company, has been appointed Manager of the Jamestown (No. Dak.) Gas Company.

MESSRS. C. W. MILLS, E. Calener and Harry Eiler have incorporated the Vienna Gas Company, to supply a like named settlement of Illinois for gas for all purposes. This place, which is the capital of Johnson County, Ills., is on the Chicago, Cincinnati and St. Louis Railroad, at a point 34½ miles northeast of Cairo, Ills. It is quite a banking place, and has a population of not far from 3,500. The place is compactly built, and its value as a gas distributing point may not be considered alone from numbers of residents. There are probably 600 separate families in Vienna, and of these 66 per cent. could easily be reckoned as requiring separate meters.

The Market for Gas Securities.

There was some animation shown in the week in the gas share list, and transfers were made at a slight advance over recently quoted prices. For instance, Consolidated shows a gain of ¼ point. The bid and asked this morning (Friday) were from, respectively, 144¼ to 144½. It is rather queer that the movement was not more pronounced, for it is almost a certainty that trouble over the coal situation is not at all likely.

Brooklyn Union shows a gain about equal to that instanced in Consolidated, the ratings being 143 to 144. Washington gas is very much in demand, the nominal gain in the week having been no less than 12½ points. As a known capital stock issue is more easily and safely determined than, say, in the instance of visible supplies of corn, wheat or the like, perhaps persistent purchase of Washington gas on certain long accountmay speedily see Washington gas at 500 or over.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

115 BROADWAY, NEW YORK CITY.

APRIL 29.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share:

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked*
Consolidated Gas Co.	$78,177,000	100	144¼	144½
Central Union Gas Co.—				
1st 5's, due 1972, J. & J.	3,000,000	1,000	103	105
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	105	105
Mutual Gas Co.	3,500,000	100	161	175
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	101	102½
New York & Richmond Gas				
Co. (Staten Island)	1,500,000	100	35	50
1st Mtg Gold Bds. 5 p. ct.	1,500,000	—	98¼	100½
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	103	105
Con. 5's, due 1945, J. & J.	1,500,000	—	95	100
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	100	102
Standard	5,000,000	100	61	70
Preferred	5,000,000	100	90	100
1st Mtg. 5's, due 1930, M. & N.	1,500,000	1,000	103	105
The Brooklyn Union	15,000,000	1,000	143	144
1st Con. 5's, due 1948, M. & N.	15,000,000	—	106¼	107
Yonkers	299,650	500	180	—
Out-of-Town Companies.				
Bay State	50,000,000	50	⅛	¾
" Income Bonds	2,000,000	1,000	—	75
Binghampton Gas Works	450,000	100	—	—
" 1st Mtg. 5's	500,000	1,000	97	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	5	8
Bonds, 5's	5,250,000	1,000	59	60
Capital, Sacramento	500,000	50	—	35
Bonds (6's)	150,000	1,000	—	—
Chicago Gas Co. Guaranteed				
Gold Bonds	7,660,000	1,000	104	106¼
Cincinnati Gas and Electric				
Co.	29,500,000	100	87	90
Columbus (O.) Gas Co., 1st				
Mortgage Bonds	1,500,000	1,000	96	98
Columbus (O.) Gas Lt. &				
Heating Co.	1,682,750	100	90½	91
Preferred	3,026,500	100	75½	80
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	13,460,084		—	—
Mortgages, 5's	3,400,000		—	—
General Mortgage 4½	10,661,0 0		—	—
Con. Gas Co., Baltimore				
City, 4½	2,751,000		—	—
Consolidated Gas Co. of N. J.	1,000,000	100	15	—
Con. Mtg. 5's	976,000	1,000	94	96
Bonds	75,000	—	—	100
Detroit City Gas Co.	6,580,000	—	—	50
Detroit Gas Co., 5's	881,000	1,000	75	80
" Prior Lien 5's	5,619,000	1,000	97	100½
Equitable Gas & Fuel Co.,				
Chicago, Bonds	2,000,000	1,000	—	101
Essex and Hudson Gas Co.	6,500,000	—	133	136
Fort Wayne	2,000,000	—	—	—
" Bonds	2,000,000	—	55	—
Grand Rapids Gas Light Co.,				
1st Mtg. 5's	1,350,000	1,000	100	101
Hartford	750,000	25	190	200
Hudson County Gas Co., of				
New Jersey	10,500,000	—	130	138
" Bonds, 5's	10,500,000	—	101	106
Indianapolis	2,000,000	—	—	38
" Bonds, 5's	2,650,000	—	104½	105
Jackson Gas Co.	250,000	50	82	—
" 1st Mtg. 5's	290,000	1,000	91	95
Kansas City Gas Light Co.,				
of Missouri	5,000,000	100	—	86
Bonds, 1st 5's	3,822,000	1,000	99	102
Laclede Gas Co., St. Louis.	10,000,000	100	107¼	107½
Preferred	2,500,006	100	114	120
Bonds	10,000,000	1,000	102½	103
Lafayette Gas Co., Ind.	1,000,000	100	—	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas and Electric Co.				
" 1st Mtg. 6's	400,000	1,000	106	108½
Massachusetts Gas Companies, of Boston	25,000,000	100	89½	90
Preferred	25,000,000	100	97	97½
Montreal Gas Co., Canada	9,000,000	100	218	218½
Nashville Gas Light Co.	1,000,000	100	110	—
Newark, N. J., Con. Gas Co.	6,000,000	—	97	98
Bonds, 6's	6,000,000	—	127	128
New Haven Gas Co.	5,000,000	25	180	—
Peoples Gas Lt. & Coke Co.,				
Chicago	25,000,000	100	114	114½
1st Mortgage	20,100,000	1,000	102	102½
2d "	2,500,000	1,000	104	—
Rochester Gas & Electric Co.	2,150,000	50	88	—
Preferred	2,150,000	50	118	—
Consolidated 5's	2,000,000	—	104¾	105¼
Pacific Gas and Electric Co.	15,500,000	—	56	57
St. Joseph Gas Co.—				
1st Mtg. 5's	1,000,000	1,000	94	96
St. Paul Gas Light Co.	2,500,000	100	—	—
1st Mortgages, 6's	650,000	1,000	104	106
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	3,447,000	1,000	94	96
Syracuse Gas Co., N. Y.	1,975,000	100	50	55
Bonds	2,047,000	1,000	101	103
Washington (D. C.) Gas Co.	1,600,000	200	437½	440
1st Mortgage, 6's	600,000	—	—	—
Western Gas Co., Milwaukee	4,000,000	—	—	—
Wilmington (Del.) Gas Co.	600,000	50	—	—

MEETING TIMES OF THE VARIOUS GAS ASSOCIATIONS.

American Gas Institute.—Annual meeting, October 16 to 18, 1912. Marlborough-Blenheim Hotel, Atlantic City, N. J. Officers: President, Ira C. Copley, Aurora, Ills. Secretary, Geo. G. Ramsdell, 29 West 39th st., N. Y. City.

Canadian Gas Association.—Annual meeting and Gas Show, Toronto, Aug 26th to Sept. 7, 1912. Officers President, Arthur Hewitt, Toronto, Ont.; Secretary and Treasurer, John Keilior, Hamilton, Ont.

Empire State Gas and Electric Association.—Annual meeting, New York City, Oct. 1912. Officers: President, R. M. Searle, Rochester, N. Y.; Secretary, C. H. B. Chapin, 29 W. 39th street. New York City.

Gas Meters.—Monthly meetings. Chairman, I. W. Peffly; Secretary, H. Thurston Owens, 42 Pine street, New York City.

Guild of Gas Managers of New England.—Annual meeting, March, 1913. Young's Hotel, Boston; monthly meeting, second Saturday. Officers: President, Walter G. Africa, Manchester, N. H.; Secretary, H. K. Morrison, Brockton, Mass.

Illinois Gas Association.—Annual meeting, time, March 19th and 20th, 1913. Chicago, Ills. Officers: President, H. O. Channon, Quincy, Ills.; Secretary-Treasurer, Horace H. Clark, 115 No. Oak Park avenue, Oak Park, Ills.

Illuminating Engineering Society.—Annual meeting, Niagara Falls, Canada, Sept. — 1912. Meetings of Sections, monthly. Pres't, V. R. Lansingh, New York City; Secretary, Preston S Millar, 29 W. 39th street, N.Y. City. Sections: New York, Secretary, Albert J. Marshall, 16 East 40th street. New England, Secretary, H. C. Jones, 10 High street, Boston, Mass. Philadelphia, Secretary, L. B. Eichengreen, Broad and Arch streets. Chicago, Secretary, Edward Wray, 106 N. LaSalle street.

Indiana Gas Association.—Annual meeting, March, 1913, Indianapolis. Officers: President, Howard L. Olds, Indianapolis; Vice-President, Wm. Wallace, Lafayette; Secretary-Treasurer, Phimer Eves, Indianapolis.

Iowa District Gas Association.—Annual meeting, time, May, 22, 23 and 24, 1912; Lincoln, Neb. Officers: President, G. W. Clabaugh, Omaha, Neb.; Secretary and Treasurer, G. I. Vincent, Des Moines, Ia.

Kansas Gas, Water and Electric Light Association.—Annual meeting, time, Oct. 17-19. Manhattan, Kas. Officers: President, B. F. Eyer, Manhattan, Kas.; Secretary and Treasurer, J. D. Nicholson, Newton, Kas.

Michigan Gas Association—Annual meeting, time, Sept. ———1912;——— Officers: President, F. W. Blowers, Kalamazoo, Mich; Secretary-Treasurer, Glenn R. Chamberlain, Grand Rapids, Mich.

Missouri Electric Light, Gas, Water Works and Street Railway Association.—Annual meeting, April, 1913; Joplin, Mo. Officers: President, P. A Bertrand, Joplin, Mo.; Secretary and Treasurer, P. W. Markham, Brookfield, Mo.

National Commercial Gas Association.—Annual meeting, Dec. 2-5, 1912. Atlanta, Ga. Officers: President, C. L. Holman, St. Louis, Mo.; Secretary, Louis Stotz, 29 West 39th street, New York City.

Natural Gas Association.—Annual meeting, May 21-23, 1912, Kansas City, Mo.; Officers: President, A. B. Macbeth, Independence, Kas. Secretary, T. C. Jones, Delaware, O.

New England Gas Association.—Annual meeting, February,———1913 Boston. Officers: President, D. D Barnum, Worcester, Mass.; Secretary-Treasurer, N. W. Gifford, East Boston, Mass.

New Jersey State Gas Association.—Summer Meeting. August 24, Atlantic City, N. J.—President, William H. Pettes, Newark, N. J.; Secretary-Treasurer, Arthur H. Osborn Belmar, N. J.

Ohio Gas Association.—Annual meeting, February ———, 1913, Columbus, O.; President, John M. Garard, Columbus, O.; Secretary, L. B. Denning, Columbus, O.

Oklahoma Gas, Electric and Railway Association.—President, Noel R. Gascho, Alva Okla.; Secretary, H. V. Bozell, Norman, Okla.

Pacific Coast Gas Association.—Annual meeting, San Diego, Cal., September 17, 18, 19, 1912. Officers: President, W. Baurhyte, Los Angeles, Cal.; Vice President, Henry E. Adams, Stockton, Cal.; Secretary-Treasurer, John A. Britton, 445 Sutter street, San Francisco, Cal.

Pennsylvania Gas Association.—Annual meeting, York, Pa., April, 1913; Officers, President, H. H. Ganser, Norristown, Pa.; Secretary-Treasurer, W. O Lamson, Jr., West Chester, Pa.

Society of Gas Lighting.—Annual meeting Dec., 13, 1912; monthly meetings, second Thursday. Place, New York City. Officers: President, Fred. S. Benson; Secretary, George G. Ramsdell, 29 West 39th street, New York city

Southern Gas Association.—Annual meeting, April ——— 1913, Charlotte, N. C. Officers: President, C. E. White, Montgomery, Ala.; Secretary-Treasurer, E. D. Brewer, Atlanta, Ga.

Southwestern Electrical and Gas Association.—Annual meeting. April 25, 26, 27, 1912, San Antonio, Tex. Officers: President, J. E. Carroll, Beaumont, Tex.; Secretary, D. G. Fisher, Dallas, Tex.

Wisconsin Gas Association.—Annual meeting, May 15 and 16, 1912, Milwaukee, Wis. Officers: President, H. M. Buck, Waukesha, Wis.; Secretary-Treasurer, Henry Harmon, Milwaukee, Wis.